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EVALUATION OF ALTERNATIVES

for

POND 1 AND BELOW

Silver Bow Creek/Butte Area NPL Site
Warm Springs Ponds Operable Unit
Warm Springs, Montana

Prepared for:

ATLANTIC RICHFIELD COMPANY
555 17th Street
Denver, Colorado 80202

Prepared by:

ESA CONSULTANTS
2625 Redwing Road, Suite 135
Fort Collins, Colorado

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, MONTANA OFFICE
FEDERAL BUILDING, 301 S. PARK, DRAWER 10096
HELENA, MONTANA 59626-0096

September 27, 1991

Dear Friends of the Clark Fork River:

A year ago, the U.S. Environmental Protection Agency issued its decision for cleaning up the Warm Springs Ponds near Anaconda. The Record of Decision for the Warm Springs Ponds Operable Unit, Silver Bow Creek/Butte Area NPL Site, described in detail a remedy that will accomplish the following objectives:

1. Raise and strengthen all pond berms to withstand severe earthquakes and floods;
2. Enlarge the inlet and upgrade the pond system's treatment capabilities to treat flows up to the 100-year flood;
3. Remove tailings deposited outside of the pond berms and consolidate them behind reinforced berms;
4. Reconstruct the Mill-Willow Bypass Channel;
5. Flood (wet-close) contaminated dry portions of Pond 2;
6. Dewater and cover (dry-close) Pond 1; and
7. Defer, for not more than one year, decisions concerning the area below Pond 1.

In June 1991, the EPA issued an Explanation of Significant Differences which modified the Record of Decision. The most noteworthy aspect of the modifications involved Pond 1 and the area below Pond 1. The Record of Decision specified that Pond 1 would be dry-closed and a decision concerning the area below Pond 1 would be deferred for one year. However, while evaluating alternatives for the area below Pond 1, the EPA determined that the alternatives also have important implications on Pond 1 itself.

Neither Pond 1 nor the area below Pond 1 has a role in the treatment of water entering the pond system from Silver Bow Creek. Therefore, the Explanation of Significant Differences separated them from the active portions of the pond system (Ponds 2 and 3). This important modification has enabled the EPA to proceed with necessary work on the active treatment ponds and, at the same time, conduct a more thorough evaluation of various wet- and dry-closure alternatives for the inactive area.

In keeping with the EPA's commitment to assure that the overall remedy for the Warm Springs Ponds proceeds without delay, I am informing you of two important processes that have been initiated.

First, on September 25, the EPA signed and issued to the

Atlantic Richfield Company (ARCO) a Unilateral Administrative Order. The Order directs ARCO to design and implement the remedy described in the Record of Decision, as modified by the Explanation of Significant Differences, and to do so according to a time schedule specified in the Order. The time schedule calls for actual construction to begin in 1992 and be completed within the following 15 to 18 months.

Second, the EPA has released for public review ARCO's Draft Evaluation of Alternatives for Pond 1 and Below. The report develops and evaluates six alternatives for cleaning up or isolating the submerged tailings within Pond 1 and the former Silver Bow Creek channel below Pond 1. The report also examines a "no action" alternative, which is required by the EPA. A summary of the alternatives and a figure showing the study area, excerpted from ARCO's report, are attached.

The EPA and State are seeking input from concerned groups and individuals before any recommendation is made for or against any particular alternative for the inactive area. We are planning a 1-day workshop at Deer Lodge, October 10, and evening public meetings at Missoula, October 23, and Anaconda, October 24. We urge your participation in one or more of these forums, as the EPA will recommend one of the alternatives, or perhaps combinations of alternatives, in a proposed plan following these public meetings.

1-Day Workshop, 9:00-4:00
Powell County Community Center
Cottonwood Avenue (east of Main)
Deer Lodge, Thursday, October 10
A tour of the study area will be included.

Evening Public Meetings, 7:00-9:00
St. Patrick Hospital Auditorium
Missoula, Wednesday, October 23
and
Copper Village Museum and Art Center
Corner of Commercial and Cedar
Anaconda, Thursday, October 24

Copies of ARCO's draft report may be reviewed at the following locations:

EPA Office, Butte
Montana Tech Library, Butte
Butte-Silver Bow Library
Hearst Library, Anaconda
Nat'l Park Service, Deer Lodge
Mansfield Library, Missoula
Missoula Public Library
State Library, Helena
EPA Office, Helena

Sincerely,

John F. Wardell, Director
Montana Office

DRAFT

EVALUATION OF ALTERNATIVES

for

POND 1 AND BELOW

Silver Bow Creek/Butte Area NPL Site
Warm Springs Ponds Operable Unit
Warm Springs, Montana

Prepared for:

ATLANTIC RICHFIELD COMPANY
555 17th Street
Denver, Colorado 80202

Prepared by:

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Fort Collins, Colorado

September 4, 1991

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EVALUATION OF ALTERNATIVES

for

POND 1 AND BELOW

1.0 INTRODUCTION

1.1 Purpose

The purpose of this study is to develop and evaluate alternatives for remediation of affected media within Pond 1 and the area located immediately north of Pond 1 in the Warm Springs Ponds (WSP) Operable Unit (see Figures 1-1 and 1-2). The Record of Decision (ROD)[1] which followed the Feasibility Study (FS)[2] for the WSP Operable Unit summarizes the remedy for the area within Pond 1 and the area below Pond 1 as follows:

- Dewater wet portions of Pond 1 and cover and revegetate (dry-close) all areas within the Pond 1 berm; (page 1-3)

- Defer, for not more than one year after the effective date of this document, decisions concerning the remediation of contaminated soils, tailings and ground water in the area below Pond 1, pending evaluation of various wet and dry closure alternatives and a public review. (page 1-4)

Prior to release of the ROD, Atlantic Richfield Company (ARCO) proposed an alternative concept identified as the "Hybrid Plan" to remediate the area within Pond 1 and below.[3] The Hybrid Plan proposed a combination of wet and dry closure for this area, adopting in part the dry closure remedy described in the ROD for Pond 1. This concept is further developed and presented herein as an alternative approach to remediation of this area. In addition, several other alternatives representing combinations of various Media Specific Actions (MSAs) for media of concern have been developed and evaluated. A total of seven alternatives including a "No Action" alternative are evaluated.

1.2 Background

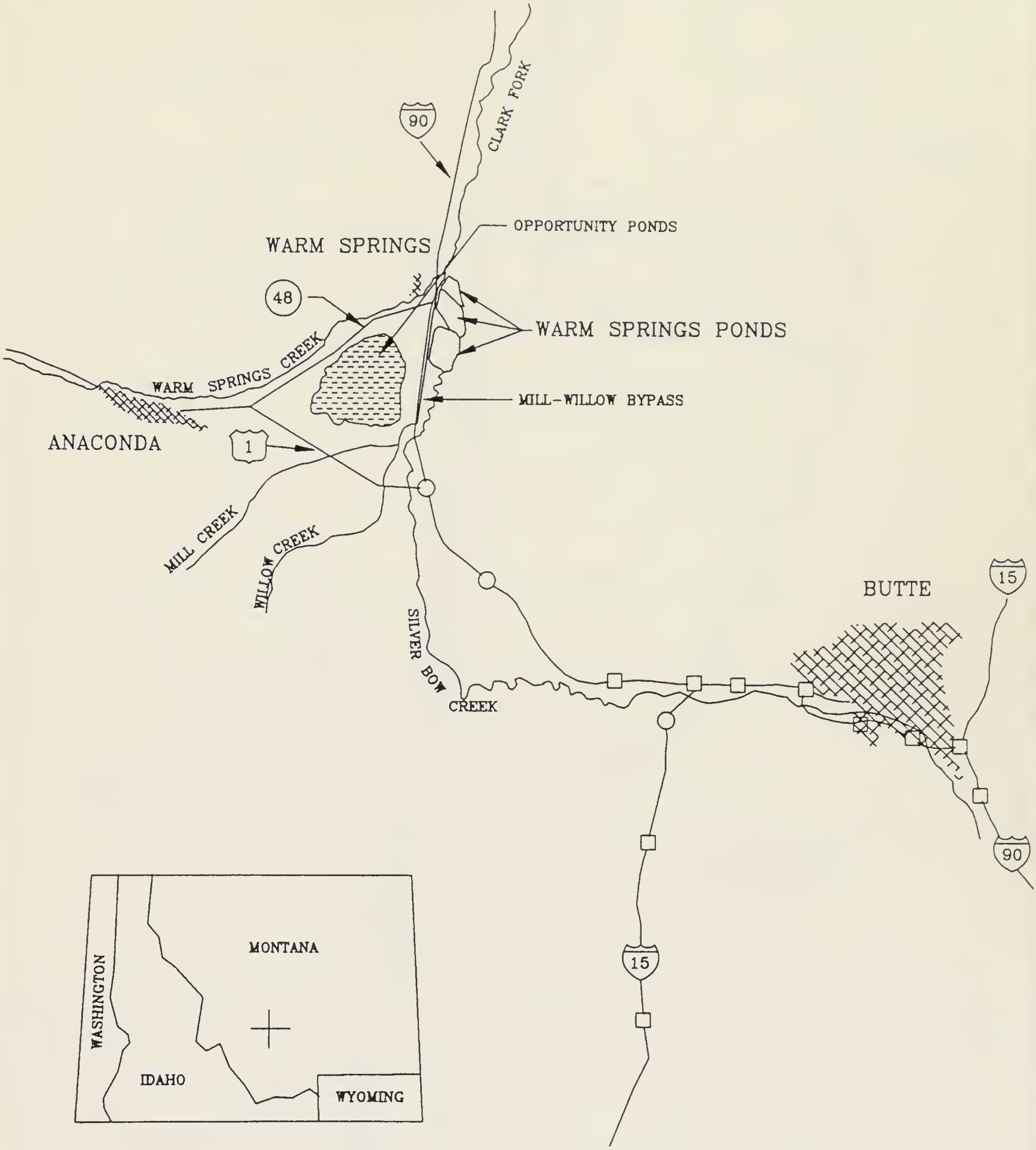
A chronology of the studies and administrative documents which have led to the development of this Evaluation of Alternatives is summarized as follows:

---

[1] United States Environmental Protection Agency (USEPA), 1990. Record of Decision, Silver Bow Creek/Butte Area NPL Site, Warm Springs Ponds Operable Unit, Upper Clark Fork River Basin, Montana.

[2] Montana Department of Health and Environmental Sciences (MDHES) and CH2M Hill, 1989. Draft Silver Bow Creek Investigation, Feasibility Study for the Warm Springs Ponds Operable Unit; October.

[3] ARCO, 1990. Hybrid Concept for Closure of Pond 1 and Area Downstream, Warm Springs Ponds Operable Unit, Montana, as submitted to USEPA, August 23, 1990.



EVALUATION OF ALTERNATIVES
FOR POND 1 AND BELOW

LOCATION MAP

Figure 1-1

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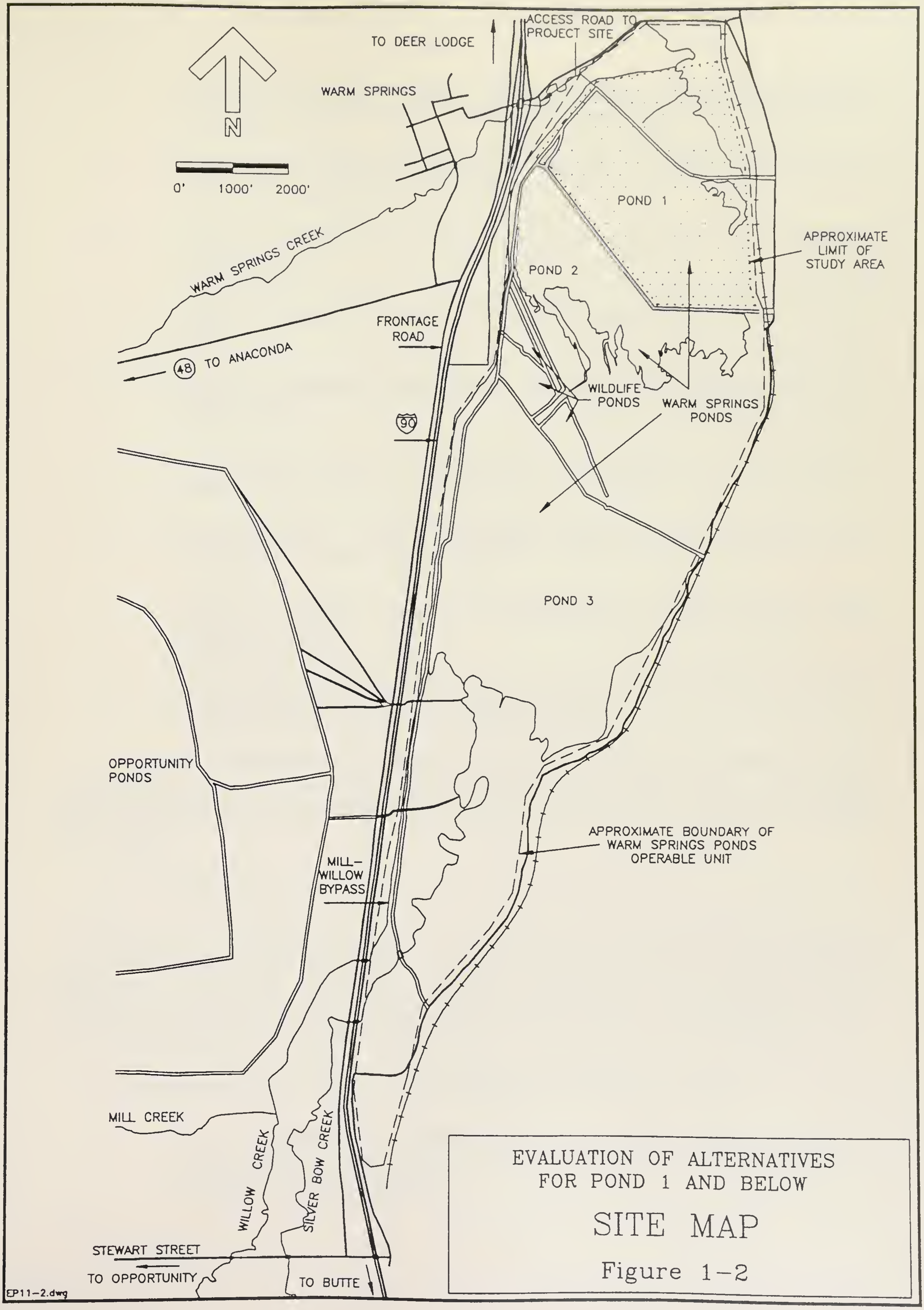

EVALUATION OF ALTERNATIVES
FOR POND 1 AND BELOW

SITE MAP

Figure 1-2

- Draft Final Phase I Remedial Investigation, prepared by Multitech for Montana Department of Health and Environmental Sciences (MDHES), March, 1987

- Final Phase II Remedial Investigation, prepared by CH2M HILL and Chen-Northern for MDHES, May 5, 1989

- Draft Feasibility Study, prepared by MDHES and CH2M HILL for MDHES, October, 1989

- ARCO Plan Alternative 3A, prepared by ESA Consultants for ARCO, November, 1989

- Review Comments on Feasibility Study, prepared by ESA Consultants for ARCO, January, 1990

- Administrative Order on Consent, Mill-Willow Bypass Expedited Response Action, Docket No. CERCLA-VIII-90-15, July 1990

- Final Work Plan - Mill-Willow Bypass Removal Action, prepared by ESA Consultants for ARCO, July 2, 1990

- Record of Decision, prepared by Environmental Protection Agency (EPA), September, 1990

- Supplemental Work Plan, Warm Springs Ponds Foundation Preparation, prepared by ESA Consultants for ARCO, January 2, 1991

All of these studies and documents, and selected references cited therein, have been reviewed for information pertinent to remediation of Pond 1 and the area below. Relevant data, analyses, interpretations, comments and requirements from these sources have been considered in this study.

1.3 Format

In preparation of this study, relevant information, discussion and evaluation from the FS and ROD for the WSP Operable Unit is hereby incorporated by reference. For example, the FS discussion related to identification, screening and selection of appropriate remedial technologies and options for the entire Operable Unit encompasses the technologies and options pertinent to this study. Therefore, that information is not repeated in this document.

This report consists of seven sections outlined and described as follows:

- **1.0 Introduction** - This section describes the purpose, background and format of this document. A summary of each alternative and of the evaluation of alternatives is also presented.

- 2.0 **Problem Definition, ARARs and Remedial Objectives** - This section provides a general description of problems which presently exist relative to the area encompassed by Pond 1, below Pond 1 to the confluence of the Mill-Willow Bypass and Silver Bow Creek, and the area north to the county road. Applicable, relevant and appropriate requirements (ARARs) and remedial objectives are also summarized for each of the affected media.

- 3.0 **Development of Media-Specific Actions** - For each media of concern, specific actions are identified which are capable of reducing or eliminating problems associated with the media.

- 4.0 **Development of Alternatives** - Alternatives for remediation of the study area are developed by combining the previously developed media-specific actions (MSAs) for the media of concern into a comprehensive plan which addresses the entire study area. A total of six action alternatives and a No Action alternative are developed.

- 5.0 **Individual Analysis of Alternatives** - Each alternative is evaluated against seven of the nine National Contingency Plan (NCP) criteria. The analysis is used as a basis for developing the rationale for a remedy selection.

- 6.0 **Comparative Analysis of Alternatives** - A comparison of the strengths and weaknesses of the alternatives relative to one another with respect to each criterion is presented.

- 7.0 **Other Considerations** - A discussion of the proposed overbank tailings remediation, ground-water monitoring program, and soils (tailings) remedial action protocol are included in this section.

1.4 Summary of Alternatives

This study evaluates six action alternatives and a No Action alternative for remediation of Pond 1 and the area below Pond 1 at the WSP Operable Unit. As described below, Alternative No. 1 is the ROD remedy, supplemented by the preferred alternative from the FS. Alternative No. 5 is a refined version of the ARCO Hybrid Plan. The other four action alternatives represent various additional combinations of remediation for the study area. Development and evaluation of these alternatives are described in Sections 3.0 through 6.0 of this report.

There are several components common to all alternatives, except Alternative No. 7 (No Action), and these are not repeated in the following subsections:

- Protection of the existing Pond 1 berm against the design probable maximum flood (PMF)-series flood

- Stabilization of the Pond 1 berm to withstand a maximum credible earthquake (MCE)

- Removal of tailings and contaminated soils from the Mill-Willow Bypass, and disposal by dry closure in Pond 1
- Establish ground-water quality monitoring to assess compliance with ARARs
- Institutional controls to control access to the site and prevent future residential and ground-water development

1.4.1 Alternative No. 1 (Dry Close Pond 1, Remove Below Pond 1)

Alternative No. 1 in this study (the ROD remedy) combines the applicable components of ROD Alternative 3+3A for Pond 1 and of Alternative 3 of the FS for the area below Pond 1. The alternative-specific components of Alternative No. 1 are summarized as follows:

- Construction of a flood interceptor channel in the east hills to protect the area within Pond 1 from flood runoff up to the 0.5 PMF
- Removal of tailings and associated soils and trench bottom deposits from areas below Pond 1, and disposal by dry closure in Pond 1
- Dewatering of the wet portions, and dry closure by capping and revegetating all areas protected by the Pond 1 dike
- Lowering of ground-water levels and interception of ground water within and immediately below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

1.4.2 Alternative No. 2 (Dry Close Pond 1, Wet Close Below Pond 1)

The alternative-specific components of Alternative No. 2 are summarized as follows:

- Construction of an extension of the north-south Pond 1 dike to protect the area below Pond 1 from floods up to the 0.5 PMF on the Mill-Willow Bypass and/or Warm Springs Creek
- Construction of a flood interceptor channel in the east hills to protect the area within and below Pond 1 from flood runoff up to the 0.5 PMF
- Wet closure/chemical fixation of the tailings and associated soils in the area below Pond 1
- Removal and disposal by dry closure in Pond 1 of minor trench bottom sediments in the area below Pond 1
- Dewatering of the wet portions, and dry closure by capping and revegetating all areas protected by the Pond 1 dike

- Lowering of ground-water levels and interception of ground water within and immediately below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

- Interception of ground water below the wet closure cells below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

- Construction of a Mill-Willow Bypass replacement channel below Pond 1

1.4.3 Alternative No. 3 (Dry Close Pond 1, Dry Close Below Pond 1)

This alternative is the same as Alternative No. 2, but proposes dry closure of the tailings and associated soils located below Pond 1 rather than wet closure/chemical fixation. The alternative-specific components of Alternative No. 3 are summarized as follows:

- Construction of an extension of the north-south Pond 1 dike to protect the area below Pond 1 from floods up to the 0.5 PMF on the Mill-Willow Bypass and/or Warm Springs Creek

- Construction of a flood interceptor channel in the east hills to protect the area within and below Pond 1 from flood runoff up to the 0.5 PMF

- Dry closure of tailings and associated soils deposits in areas below Pond 1

- Removal and disposal by dry closure of minor trench bottom sediments in the area below Pond 1

- Dewatering of the wet portions, and dry closure by capping and revegetating all areas protected by the Pond 1 dike

- Lowering of ground-water levels and interception of ground water within and immediately below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

- Interception of ground water below the dry closure below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

- Construction of a Mill-Willow Bypass replacement channel below Pond 1

1.4.4 Alternative No. 4 (Wet/Dry Close Pond 1, Remove Tailings Below Pond 1)

The alternative-specific components of Alternative No. 4 are summarized as follows:

- Construction of a flood interceptor channel in the east hills to protect the area within Pond 1 from flood runoff up to the 0.5 PMF

- Removal of tailings and associated soils and trench bottom deposits from areas below Pond 1, and disposal by dry closure in Pond 1
- Wet closure/chemical fixation of the eastern third of Pond 1
- Dry closure by capping and revegetating the western two-thirds of Pond 1
- Interception of ground water at the toe of the Pond 1 dike, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

1.4.5 Alternative No. 5 (Wet/Dry Close Pond 1, Wet Close Below Pond 1)

Alternative No. 5 is the refined ARCO Hybrid Plan. Pond 1 is remediated in the same way as in Alternative No. 4. Wet closure of the area below Pond 1 involves the same actions as for Alternative No. 2. The alternative-specific components of Alternative No. 5 are summarized as follows:

- Construction of an extension of the north-south Pond 1 dike to protect the area below Pond 1 from floods up to the 0.5 PMF on the Mill-Willow Bypass and/or Warm Springs Creek
- Construction of a flood interceptor channel in the east hills to protect the area within and below Pond 1 from flood runoff up to the 0.5 PMF
- Wet closure/chemical fixation of the tailings and associated soils in the area below Pond 1
- Removal and disposal by dry closure in Pond 1 of minor trench bottom sediments in the area below Pond 1
- Wet closure/chemical fixation of tailings and pond bottom sediments in the eastern third of Pond 1
- Dry closure of tailings and pond bottom sediments by capping and revegetating the western two-thirds of Pond 1
- Interception of ground water below the wet closure cells below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system
- Construction of a Mill-Willow Bypass replacement channel below Pond 1

1.4.6 Alternative No. 6 (Wet/Dry Close Pond 1, Dry Close Below Pond 1)

Alternative No. 6 is the same as Alternative No. 5, except that the area below Pond 1 is remediated by dry closure rather than wet closure/chemical fixation. The alternative-specific components of Alternative No. 6 are summarized as follows:

- Construction of an extension of the north-south Pond 1 dike to protect the area below Pond 1 from floods up to the 0.5 PMF on the Mill-Willow Bypass and/or Warm Springs Creek

- Construction of a flood interceptor channel in the east hills to protect the area within and below Pond 1 from flood runoff up to the 0.5 PMF

- Dry closure of tailings and associated soils deposits in areas below Pond 1

- Removal and disposal by dry closure in Pond 1 of minor trench bottom sediments in the area below Pond 1

- Wet closure/chemical fixation of tailings and pond bottom sediments in the eastern third of Pond 1

- Dry closure of tailings and pond bottom sediments by capping and revegetating the western two-thirds of Pond 1

- Interception of ground water below the dry closure below Pond 1, with pumping to Pond 3 for treatment in an upgraded WSP treatment system

- Construction of a Mill-Willow Bypass replacement channel below Pond 1

1.4.7 Alternative No. 7 (No Action)

Alternative No. 7 is the No Action alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

1.5 Evaluation Summary

Individual and comparative analyses of the six action and the No Action alternative are presented in Sections 5.0 and 6.0, respectively. Following is a summary of the conclusions from those analyses.

All six of the action alternatives provide significant protection of human health and the environment. The degree to which the various alternatives accomplish this objective varies somewhat for specific components of the proposed remediation, but the overall level of protection is comparable for all alternatives. All of the action alternatives may be designed to comply with ARARs for the four media of concern. There are no substantive differences in the degree of compliance among the alternatives. The magnitude of residual risk associated with any of the alternatives is very low and the required controls are fully adequate. Thus, the minor differences in long-term effectiveness and permanence among the action alternatives are insignificant in terms of the comparative evaluation.

All of the action alternatives will equally reduce the toxicity and mobility of those metals in intercepted ground water which are treated in Pond 3. Alternatives No. 2 and No. 4-6 all incorporate wet closure and associated source control by chemical fixation. These controls

include lime application to the tailings or sediments prior to inundation, circulation of high pH water through the wet closures, and natural biologic activity. Reductions in toxicity and mobility of metals will result from these controls, with the amount of reduction generally proportional to the area of wet closure and volume of underlying metals bearing tailings or sediments. Thus, Alternative No. 5 would achieve the greatest reductions, and Alternative No. 2 the least. Lowering of the ground-water levels in Pond 1 full dry closures proposed in Alternatives No. 1-3 may increase the mobility of metals to the underlying ground water, but would not alter their toxicity. Alternatives No. 1 and No. 4 reduce the areal extent of tailings and associated soils by requiring removal below Pond 1.

With the exception of environmental impacts, all six action alternatives are generally comparable in terms of their short-term effectiveness. No significant risks to the surrounding community or workers are anticipated with any alternative, and all can be implemented within a two-year construction period. The primary difference among the alternatives is the nature and degree of short- and long-term environmental impacts. Alternative No. 1 would result in irreversible loss of all the existing waterfowl habitat both within and below Pond 1. Alternative No. 4 would eliminate the wetland below Pond 1, and Alternatives No. 2 and No. 3 would result in loss of the wetlands within Pond 1. The removal and/or dry closure areas proposed instead of wet closures under these alternatives would replace the existing waterfowl habitat with grassland habitat typical of the extensive existing grasslands already predominant in the site area. At the other extreme, Alternative No. 5 would expand and enhance the existing wetlands and waterfowl habitat both within and below Pond 1 through wet closure. Alternatives No. 4 and No. 6 would provide similar benefits, but only within the wet-closed portion of Pond 1. All six action alternatives would create a positive environmental impact by establishing grassland habitat in the presently unvegetated areas of exposed tailings in the western portion of Pond 1.

All of the action alternatives can be constructed and operated utilizing available equipment, services and technologies. Although minor differences in the type and degree of physical and/or institutional controls would result among the alternatives, all components of the remediation proposed for each alternative would be highly reliable. All alternatives can be inspected and monitored effectively to establish compliance with ARARs and ensure continued protection of human health and the environment.

The total estimated construction cost to implement the action alternatives varies from $30,997,008 for Alternative No. 1 to $16,578,211 for Alternative No. 5. These estimates include Division 1 costs (mobilization, insurance, bonding, etc.) as 11 percent and contingency costs as 15 percent of basic construction cost. The differences in cost among the alternatives are primarily associated with the higher costs of removal and/or dry closure as compared to wet closure. Operation and maintenance costs are nominal for all action alternatives, ranging from $70,000 for Alternative No. 5 to $25,000 for Alternative No. 1. Present worth costs incorporating operation and maintenance at five percent for 30 years are less than 6.5 percent greater than construction cost for all alternatives.

In conclusion, the two primary differences among the alternatives evaluated are the scale and nature of environmental impacts and the cost of implementation. Alternative No. 1 would result in the greatest negative environmental impacts during the short- and long-term, and is the most costly alternative. Alternatives No. 1 and No. 4 consolidate tailings and associated soils

within Pond 1 and thereby eliminate them as sources of contamination in the area north of Pond 1. Alternative No. 5 provides the greatest environmental benefits and is least costly. The remaining action alternatives are intermediate to Alternatives No. 1 and No. 5 both in terms of environmental impact and cost.

2.0 PROBLEM DEFINITION, ARARS AND REMEDIAL OBJECTIVES

Characterization of site conditions, problem definition, ARARs and remedial objectives for the various media in and below Pond 1 are summarized in the following subsections. This characterization is based on data collected during the Phase I and Phase II Remedial Investigations (RIs)[4], results of additional exploration and testing related to the Mill-Willow Bypass Removal Action, and recent exploration in the area below Pond 1 performed for this study. The four media of interest are addressed independently in the following subsections.

2.1 Media 1 - Pond Bottom Sediments

2.1.1 Problem Definition

All exposed, vegetated and/or submerged tailings and associated soils within the existing Pond 1 embankment are categorized as pond bottom sediments in the ROD and FS. The nature, location and volume of pond bottom sediments are described in Part II, Section 4.0 of the ROD and Chapters 2 and 4 of the FS. The primary concern identified in the ROD related to pond bottom sediments is the potential for release of these materials into the Mill-Willow Bypass and offsite as a result of a flood or earthquake event. In addition, there is potential for direct human and/or environmental contact with exposed sediments within Pond 1. Migration of dissolved metals from the pond bottom sediments to underlying ground water apparently occurs by saturated and/or unsaturated flow.

2.1.2 ARARs

The most significant state and federal ARARs identified in the ROD related to management of pond bottom sediments are the Montana Dam Safety Act, the Montana Floodplain and Floodway Management Act, the Montana Solid Waste Act, and implementing regulations under each. In terms of this evaluation, the significant elements of the dam safety ARAR are flood and earthquake design criteria.

High hazard dams must be capable of safely withstanding the inflow design flood (IDF). The size of the IDF is determined by reference to Table A in the regulations which relates flood size to dam height and storage (ARM 36.14.502). For purposes of this evaluation, all ponds

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[4] MultiTech, 1987. Remedial Investigation Final Report, Appendix C, Part 1, Warm Springs Ponds Investigation: draft report prepared for Montana Department of Health and Environmental Sciences.

CH2M HILL and Chen-Northern, 1989. Final Silver Bow Creek CERCLA, Phase II Remedial Investigation Data Summary, Warm Springs Ponds Operable Unit: report prepared for Montana Department of Health and Environmental Sciences.

and/or wet-closure cells which are part of any alternative are classified as high hazard, and will be individually or collectively protected, as appropriate, for flood flows up to the 0.5 PMF.[5]

The dam safety regulations also require that the design of high hazard dams "be such that the most severe earthquake that can be reasonably anticipated will not cause catastrophic failure and loss of life" (ARM 36.14.501 (g)). For purposes of this evaluation, it is assumed that high hazard dams must be designed to withstand the MCE without catastrophic failure. The definition of the MCE by the Corps of Engineer's as "the earthquake that would cause the most severe vibratory ground motion or foundation dislocation capable of being produced at the site under the currently known tectonic framework"[6] is adopted for this study.

2.1.3 Remedial Objectives

The remedial objectives stated in the ROD to address pond sediments are to "Prevent the release of the pond bottom sediments from design floods and earthquakes" (Part II, § 8.0, Table 3, p. 2-40). Because much of these materials are currently exposed within Pond 1, an additional remedial objective is to reduce the potential for direct human and environmental exposure, especially where necessary to protect human health. This is the stated remedial objective for tailings and associated soils. Consideration must also be given to the interrelationship between the tailings and the underlying ground water.

2.2 Media 2 - Surface Water

2.2.1 Problem Definition

Two surface-water issues have been identified related to remediation of Pond 1 and the area below. First, erosion of exposed tailings and associated soils (and conceivably pond bottom sediments) as a result of high runoff associated with flooding could occur. The eroded materials may be transported down Silver Bow Creek and eventually reach the Clark Fork River. Second, surface runoff over exposed tailings may dissolve metals salts and contribute additional metals loadings to Silver Bow Creek and the upper Clark Fork River.

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[5] The regulations do not specifically address dams in series in regard to the required IDF. However, the ROD states that "All north-south berms along the Mill-Willow Bypass would be raised and strengthened to protect against failure during flood flows up to 70,000 cfs, which is one-half the peak flow rate of a probable maximum flood" (p. 2-51). It is assumed for purposes of this evaluation that all of the area within Pond 1 and areas below Pond 1 remediated by wet or dry closure will be protected for flood flows up to the 0.5 PMF.

[6] National Research Council, 1985. Safety of Dams, Flood and Earthquake Criteria: report by the Committee on Safety Criteria for Dams, Water Science and Technology Board, Commission on Engineering and Technical Systems of the National Research Council; National Academy Press, Washington, D.C., 276 pp.

2.2.2 ARARs

The ROD lists specific ambient and point source water quality standards, monitoring requirements, and other state and federal requirements for surface-water remedial action. These requirements are not directly related to selection of a remedy for Pond 1 and the area below Pond 1. However, final selection of the ambient surface-water quality compliance point should be consistent with establishment of the waste unit boundary and the features of the selected alternative.

2.2.3 Remedial Objectives

The remedial objectives for surface water related to Pond 1, as summarized from the ROD, are as follows:

- Meet point source and ambient water quality standards for aquatic life at the defined compliance points

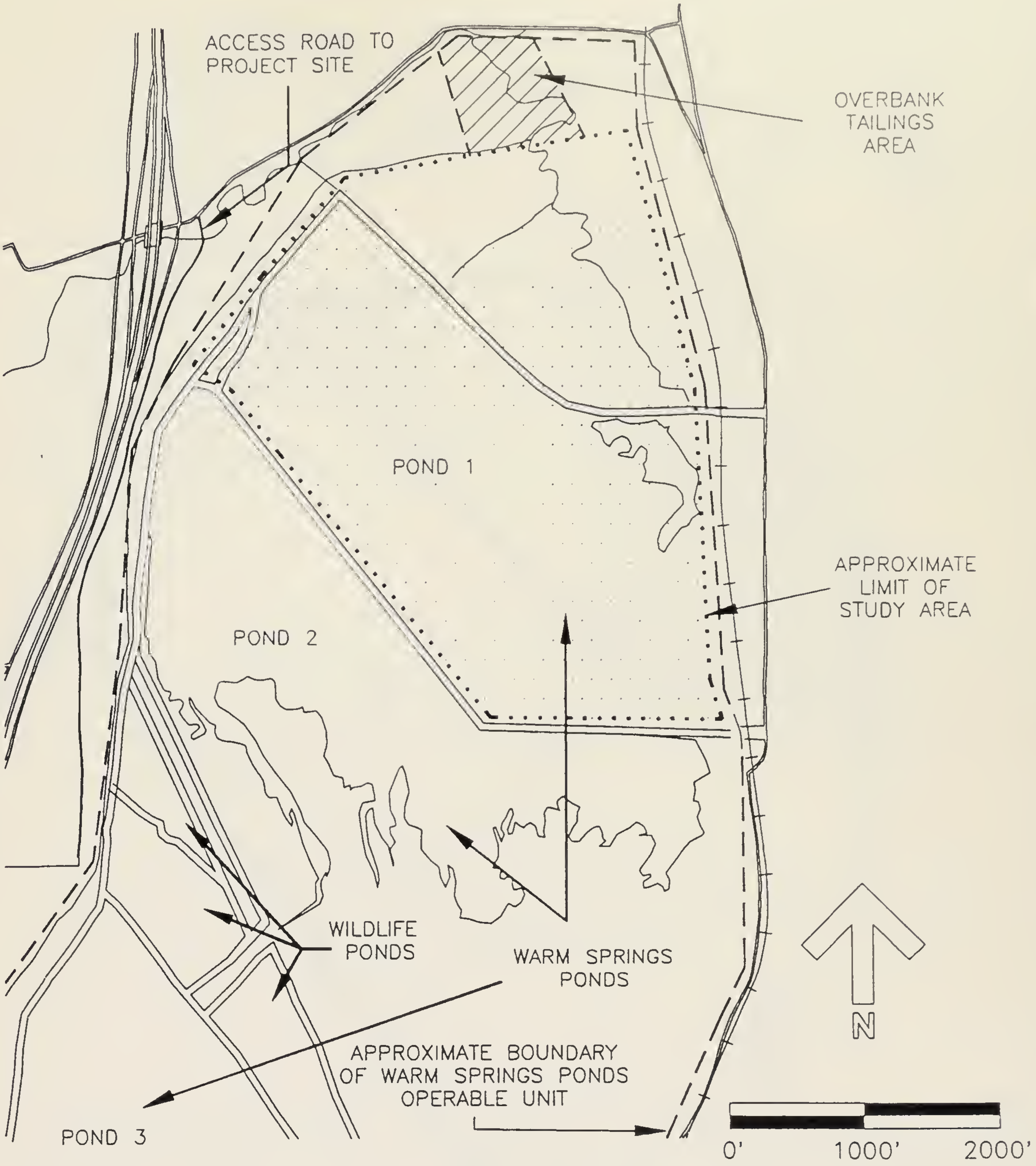
- Reduce to acceptable limits or eliminate the potential for tailings to reach the Clark Fork River

2.3 Media 3 - Tailings and Associated Soils

2.3.1 Problem Definition

Tailings and associated soils containing varying concentrations of metals are present below Pond 1 to the Operable Unit boundary. For the purposes of this evaluation, remediation of the downstream tailings and associated soils from the confluence of the Mill-Willow Bypass and the lower Silver Bow Creek channel to the Operable Unit boundary is considered separately under Section 7.1 (see Figure 2-1). The approach selected for remediation of this area is independent of the alternatives evaluation, and thus is not included in the individual or comparative analyses.

The area and volume of tailings deposits and associated soils below Pond 1 to the Operable Unit boundary, as described in the ROD (Part II, § 4.3.1, p. 2-12), are estimated to be approximately 76 acres and 474,400 cubic yards, respectively. Proportioning the ROD volume estimates on the basis of area results in an estimate of 390,600 cubic yards of tailings and associated soils for the 63 acres below Pond 1 to the Bypass shown on Figure 2-2. Based on additional investigations conducted by ARCO, the actual area and volume above the Bypass may be closer to 70 acres and approximately 283,000 cubic yards, respectively. In addition, there are approximately 10 acres of old man-made channels and trenches below Pond 1 which contain bottom sediments similar to those in Ponds 2 and 3. The estimated volume of trench bottom sediments is approximately 10,000 cubic yards. The actual volumes of materials which would have to be excavated to accomplish a complete removal of these tailings and associated soils may be significantly greater than the volumes estimated above, as discussed below in Section 3.3.2.


ACCESS ROAD TO PROJECT SITE
OVERBANK TAILINGS AREA
POND 1
APPROXIMATE LIMIT OF STUDY AREA
POND 2
WILDLIFE PONDS
WARM SPRINGS PONDS
APPROXIMATE BOUNDARY OF WARM SPRINGS PONDS OPERABLE UNIT
POND 3
N
0'
1000'
2000'

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

STUDY AREA AND OVERBANK TAILINGS AREA

Figure 2-1

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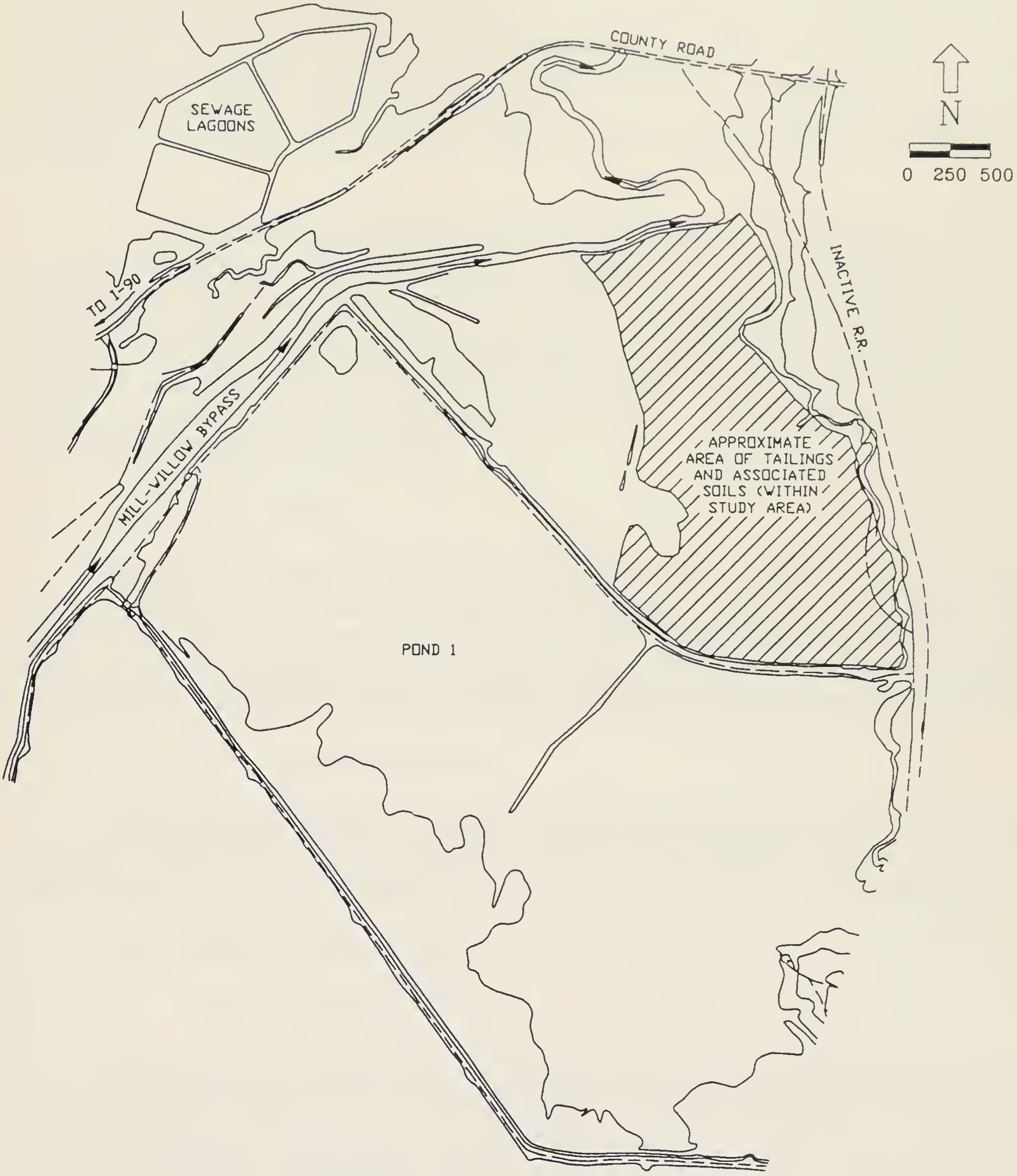

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

TAILINGS LOCATION MAP

Figure 2–2

EP12-2.dwg

ARCO's revised estimates of the areal extent and volume of tailings and associated soils, and trench bottom sediments is based on the results of a field investigation conducted in December 1990 and January 1991. The objective of the investigation was to supplement existing RI information with additional subsurface profiles to visually confirm, as accurately as possible, the extent and thickness of tailings deposits and to identify the nature of pond bottom sediments in man-made trenches/channels. The investigation included a reconnaissance survey and the excavation of 79 backhoe test pits. Soil profile logs and locations of the test pits are presented in Appendix A.

The primary pathways identified and described in the ROD for potential human exposure to tailings and associated soils are direct contact, inhalation of dust from the surface of deposits, and incidental ingestion. The Public Health and Environmental Assessment (PHEA) for the Operable Unit discusses these three exposure routes and the potential health hazards associated with each.[7] Contact with tailings may also pose a potential threat to terrestrial and aquatic organisms. Soluble metal salts formed on exposed tailings surfaces may be a source of metal loadings to surface water during runoff events. In addition, contamination of the ground water underlying the tailings has been reported.

2.3.2 ARARs

There are no ARARs for tailings and associated soils. Alternatively, the continued use of the approach followed to identify tailings and associated soils under the Mill-Willow Bypass Removal Action is appropriate for identification of tailings and associated soils within and below Pond 1. The results of the Mill-Willow Bypass Removal Action and the proposed tailings and associated soils remediation protocol for Pond 1 and the area below are described in Section 7.3.

2.3.3 Remedial Objectives

The remedial objectives for tailings and associated soils are to reduce the potential for exposure to exposed tailings and associated soils to levels protective of human health and the environment, and to control releases of these materials to surface water and ground water.

2.4 Media 4 - Ground Water

2.4.1 Problem Definition

Ground water in the shallow aquifer beneath Pond 1 and the area below flows northward and ultimately discharges to the Mill-Willow Bypass, Silver Bow Creek below the Bypass to its confluence with Warm Springs Creek, or the Clark Fork River. A total of 11 RI monitoring wells were installed in the shallow aquifer as shown on Figure 2-3. Ground-water sample analysis results from these wells indicate some degradation of the shallow aquifer. Table 2-1 lists RI analysis results for arsenic and cadmium for samples collected from the wells shown on Figure 2-3. Lead concentrations in ground-water samples collected from all monitoring wells were consistently below the maximum contaminant level (MCL) of 0.05 mg/l.

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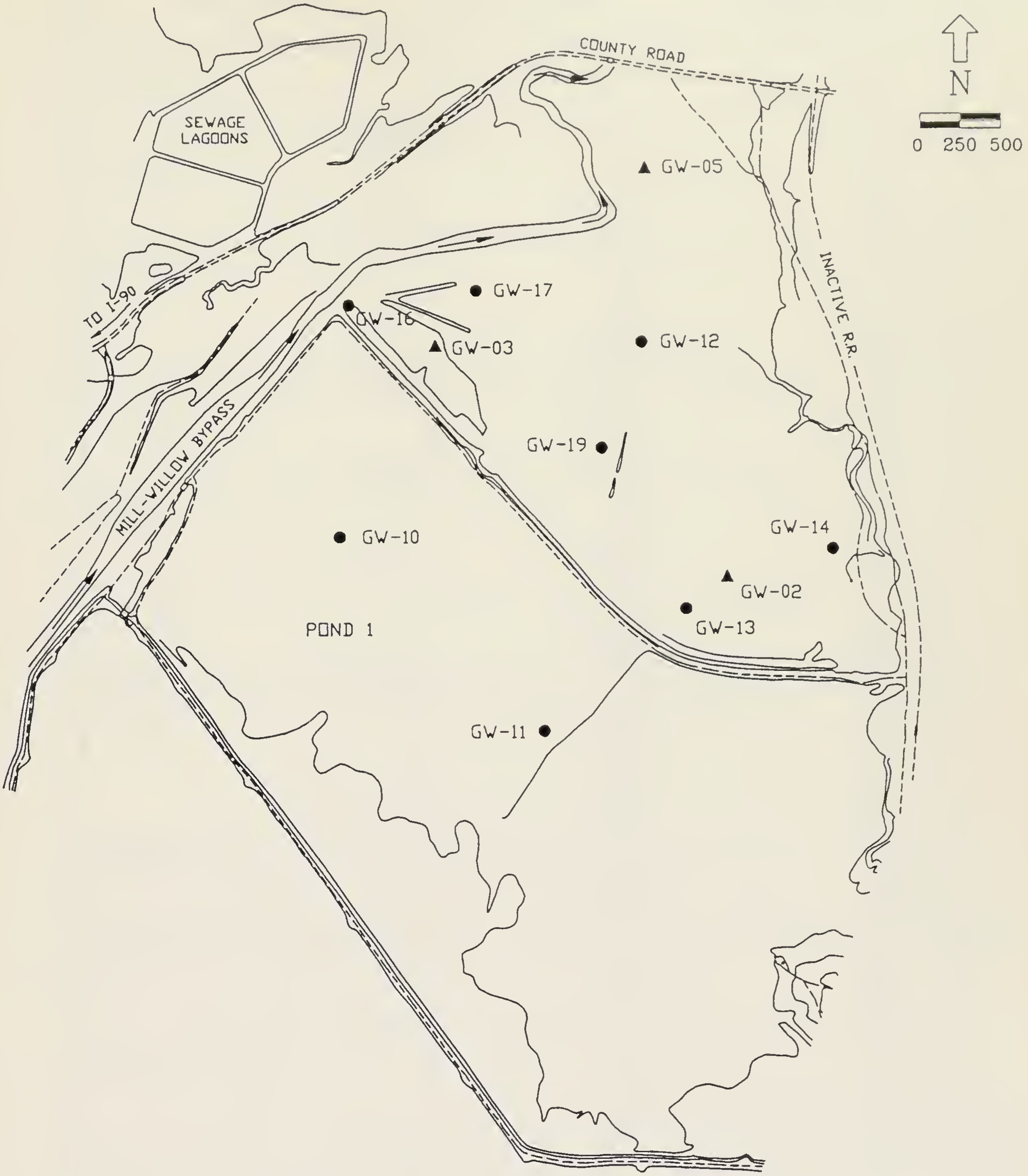
[7] FS, Appendix A.



EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

MONITORING WELL LOCATION MAP

Figure 2–3

EP12-3.dwg

Table 2-1
Summary of Shallow Ground-Water Quality Data for Pond 1 and Below

Well Number	Dissolved Arsenic mg/l	Dissolved Cadmium mg/l
GW-10S	0.014	<0.005
(Pond 1)	0.017	<0.005
Average	0.016	<0.005
GW-11S	0.033	0.006
(Pond 1)	0.105*	<0.005
Average	0.07*	<0.006
GW-05	0.0018	0.0019
	0.0027	0.0008
	0.0049	<0.0050
	<0.0020	0.0127*
Average	0.004	0.005
GW-16S	<0.0002	<0.005
	<0.002	<0.005
Average	<0.002	<0.005
GW-17	0.0049	<0.005
	0.002	0.0117*
Average	0.004	0.008
GW-12S	0.0024	0.0090
	<0.0020	0.0068
Average	0.002	0.008
GW-03S	<0.0075	0.0006
	<0.0042	0.0007
	<0.0020	<0.0050
	<0.0020	0.0083
Average	<0.004	0.004
GW-19S	<0.002	0.0050
	<0.002	0.0071
Average	<0.002	0.006
GW-14S	0.0036	<0.005
	0.0071	<0.005
Average	0.005	<0.005
GW-02S	0.165*	0.0014
	0.244*	0.0014
	0.072*	0.0050
	0.197*	0.0107*
Average	0.128*	0.005
GW-13S	0.041	<0.0050
	0.061*	0.0115*
Average	0.05*	0.008

*Value equal to or greater than maximum contaminant level (MCL) for parameter: 0.05 mg/l for arsenic; 0.01 mg/l for cadmium

Average values calculated by using analytical method detection limit value for values reported as less than (<) detection limit.

Exceedances of the MCLs for arsenic (0.05 mg/l) and cadmium (0.01 mg/l) were identified during the RI in the shallow aquifer beneath Pond 1 and the area below. Consistent exceedances of the arsenic MCL have been identified in the vicinity of one of the monitoring wells, GW-02S. This monitoring well is located downgradient of Pond 1 within the historic Silver Bow Creek drainage, which has been inundated with tailings deposits. One of two samples of ground water collected from each of two other wells (GW-11S within Pond 1 and GW-13S downgradient of Pond 1) exhibited exceedances of the arsenic MCL at 0.105 and 0.061 mg/l, respectively. There were four slight exceedances of the cadmium MCL out of the 28 samples collected during the RI. These exceedances were detected in one sample from each of four monitoring wells downgradient of Pond 1 (GW-02S, GW-05, GW-13S, and GW-17S).

The available data indicate that the isolated contamination events within and just below Pond 1 are well dispersed or otherwise attenuated before ground water discharges to surface waters downgradient. Ground-water discharge from the WSP Operable Unit below Pond 1 does not have a measurable impact upon ambient water quality in the Clark Fork River (see FS, p. 4-38). Although ground water leaving the Operable Unit may not pose a significant threat to human health or the environment under current conditions, there is some potential for increased metals loadings and/or downgradient migration of contaminants in the future.

2.4.2 ARARs

MCLs have been adopted by the State of Montana as water quality standards for Class II ground water, and are listed in the ROD (Attachment to Part II, p. 3).[8] As described in the ROD, the point of compliance for ground water will vary depending upon the remedial action alternative (removal vs. wet or dry closure) implemented for the area below Pond 1.

2.4.3 Remedial Objectives

The remedial objective for ground water as stated in the ROD is to "reduce the metals contamination in the ground water down gradient of the ponds to achieve compliance with maximum contaminant levels" (Part II, § 8.0, Table 3, p. 2-40). This objective is interpreted to require compliance with MCLs for ground-water discharge which ultimately flows offsite as surface water in the Mill-Willow Bypass.

3.0 DEVELOPMENT OF MEDIA-SPECIFIC ACTIONS

Remedial technologies and process options were screened and selected process options were assembled into media-specific actions (MSAs) in Chapter 6 of the FS for the WSP Operable Unit. Twelve media-specific actions were assembled in the FS to address the four site media: pond bottom sediments, surface water, tailings deposits and associated soils, and ground water. Many of these twelve MSAs were retained or modified for the development of the alternatives included in this study.

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[8] There is an error in the ROD listing of the MCL values for arsenic (I.1.A., 0.02 mg/l) and mercury (I.1.M., 0.0002 mg/l). The correct MCL values are 0.05 mg/l for arsenic and 0.002 mg/l for mercury.

The fourteen media-specific actions utilized for this study are listed in Table 3-1. The various actions which have been developed as part of this study and which make up the major components of the alternatives developed have been assigned to specific media to conform to the MSA format in the FS. However, many specific actions relate to more than one media and could be assigned to a different media than has been chosen for this study.

TABLE 3-1
MEDIA-SPECIFIC ACTIONS

MEDIA-SPECIFIC ACTION	DESCRIPTION
MSA 1A	Dike Improvements, East-West Dike of Pond 1
MSA 1B	Dry Close All of Pond 1
MSA 1C	East Hills Flood Interceptor Channel - Pond 1
MSA 1D	Dry Closure of Pond 1 - Western Portion
MSA 1E	Wet Closure/Chemical Fixation of Pond 1 - Eastern Portion
MSA 2A	Pond 1 Dike Extension - Area Below Pond 1
MSA 2B	East Hills Flood Interceptor Channel - Area Below Pond 1
MSA 3A	Wet Closure/Chemical Fixation - Area Below Pond 1
MSA 3B	Remove Tailings and Associated Soils - Area Below Pond 1
MSA 3C	Dry Closure Area Below Pond 1
MSA 4A	Ground-Water Interception and Pumpback System - Pond 1
MSA 4B	Ground-Water Interception and Pumpback System - Below Pond 1
MSA 4C	Ground-Water Interception and Pumpback System - Toe of Pond 1 Dike
MSA 4D	Mill-Willow Bypass Replacement Channel

3.1 Media-Specific Actions - Pond Bottom Sediments

Pond 1 is susceptible to flooding and potential overtopping of the dikes from large storm events over the hills to the east of the WSP Operable Unit. In addition, the existing north-south Pond 1 dike along the Mill-Willow Bypass could fail due to scouring during a major flood along the Mill-Willow Bypass. The existing Pond 1 dikes may also be susceptible to failure during major earthquakes. Exposed or partially vegetated pond bottom sediments in a major portion of the pond area are also available to direct human or environmental contact and susceptible to wind erosion. The five media-specific actions described in the following paragraphs are designed to address these issues.

Remediation of the north-south Pond 1 dike to address flood and earthquake protection is addressed separately from the remediation for Pond 1 and the area below in the FS and ROD. Thus, in order to maintain a valid comparison between alternatives, this portion of the Pond 1 dike is not specifically addressed in this study, and no MSA has been developed for it. The north-south dike would, however, be remediated under all alternatives to withstand the MCE and provide protection up to the 0.5 PMF as part of the remedy for Pond 1 and the area below.

3.1.1 MSA 1A - Dike Improvements, East-West Dike of Pond 1

Improvements are proposed which will stabilize the existing east-west portion of the Pond 1 dike to prevent failure during a MCE. Preliminary geotechnical investigations indicate that the existing dikes could be unstable during a major seismic event. The east-west segment of the dike will be lowered by a sufficient amount to maintain minimum freeboard on the wet- and dry-closed areas. Lowering the crest of the embankment will improve dike stability. Stability analyses will be performed to determine what, if any, additional measures would be required to provide adequate factors of safety for the Pond 1 dike under appropriate design conditions.

3.1.2 MSA 1B - Dry Close All of Pond 1

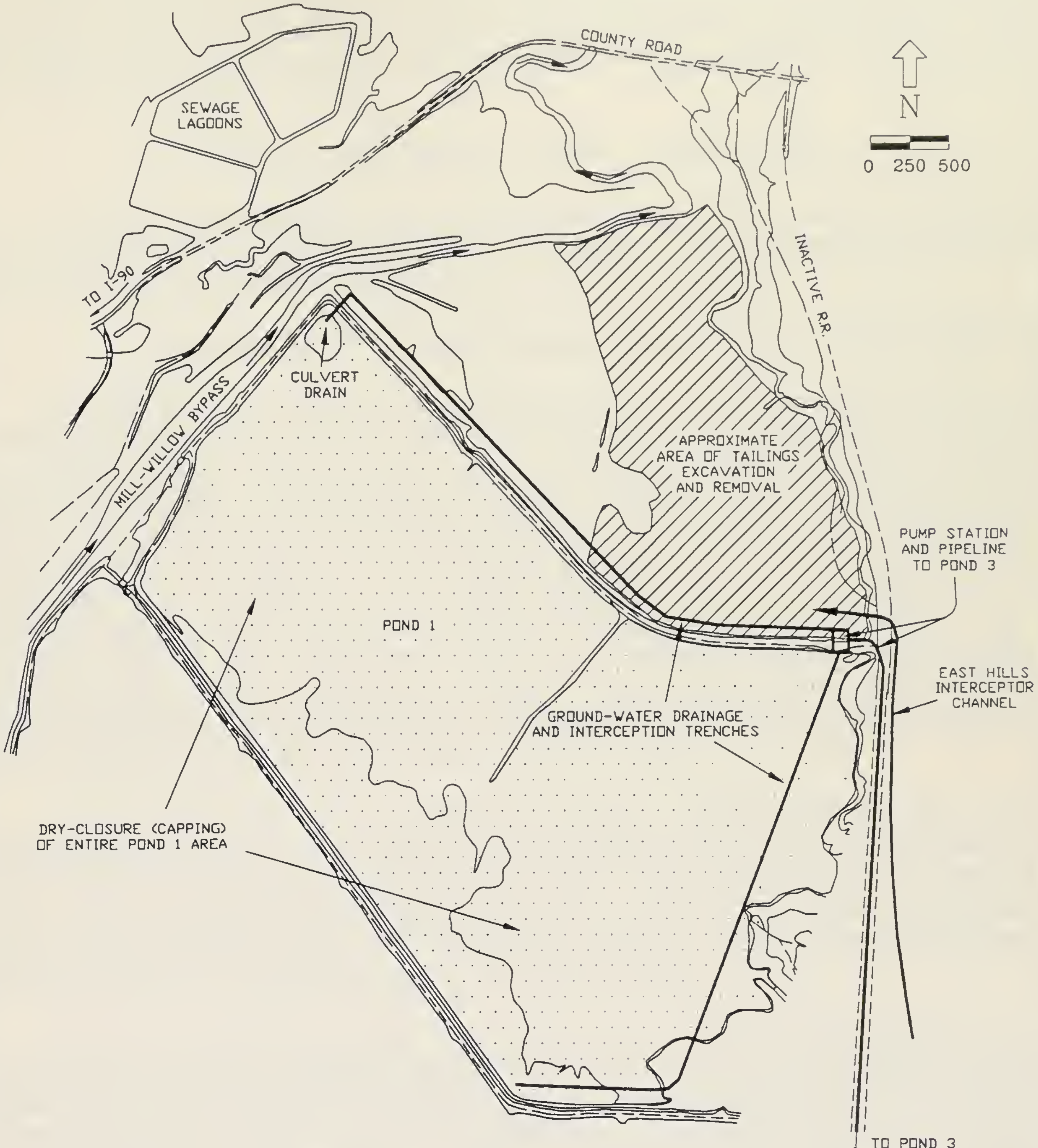
Pond 1 is no longer used as part of the treatment system for Silver Bow Creek. It is filled with tailings and sediments (i.e., pond bottom sediments) deposited during the early 1900s when it was an active impoundment. The only inflows to Pond 1 are seepage from Pond 2 and the hills to the east, surface runoff from the east hills and direct precipitation.

Pond 1 is characterized by three fairly distinct areas that roughly divide the pond into thirds. The eastern third of the pond supports an established wetland with significant, largely riparian vegetation in the southern portion and an area of shallow open water in the northern part. Relatively diverse flora and fauna populations exist in this area. The middle third of the pond consists primarily of tailings deposits and sediments with little vegetation. The western third of the pond surface is dry, with sparse to moderate native grass cover. Some areas of exposed tailings are present in the western third. The total volume of exposed tailings and sediments in Pond 1 has been estimated to be 734,000 cubic yards in the FS. The FS estimates that vegetated and submerged tailings and sediments account for an additional 2,156,000 cubic yards.

To limit environmental and human health exposures, a total dry-closure remedy would isolate the tailings within Pond 1 by grading and capping as shown in Figure 3-1. The entire Pond 1 area would be covered with approximately two inches of crushed limestone, 12 inches of fill, and six inches of topsoil. The six-inch topsoil requirement is consistent with the dry-closure cover requirements utilized for the Mill-Willow Bypass Removal Action.

3.1.3 MSA 1C - East Hills Flood Interceptor Channel - Pond 1

This media-specific action would provide a portion of the flood protection for Pond 1 for flood events up to the 0.5 PMF. Thunderstorm runoff up to the peak discharge from a 0.5 PMF from the hills east of Pond 1 will be intercepted and routed around the closure area by a channel aligned approximately as shown on Figure 3-1. The channel will be constructed primarily in


COUNTY ROAD
SEWAGE LAGOONS
N
0 250 500
TO I-90
INACTIVE R.R.
CULVERT DRAIN
MILL-WILLOW BYPASS
APPROXIMATE AREA OF TAILINGS EXCAVATION AND REMOVAL
PUMP STATION AND PIPELINE TO POND 3
POND 1
EAST HILLS INTERCEPTOR CHANNEL
GROUND-WATER DRAINAGE AND INTERCEPTION TRENCHES
DRY-CLOSURE (CAPPING) OF ENTIRE POND 1 AREA
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

MEDIA–SPECIFIC ACTIONS FOR FULL DRY CLOSURE OF POND 1 AND REMOVAL BELOW POND 1

Figure 3–1

EP13-1.dwg

cut to reduce the need for erosion protection in the channel (see Cross Section A-A', Figure 3-2). However, slope and/or bottom armoring, check or drop structures, and energy dissipation structures would be incorporated as necessary based on Remedial Design analyses. The interceptor channel would originate near the east end of the Pond 2 dam and extend northward to a point north of the Pond 1 dike.

3.1.4 MSA 1D - Dry Closure of Pond 1 - Western Portion

A description of the pond bottom sediments and the rationale for closure of the Pond 1 area is included in the description of MSA 1B. This MSA is identical except that dry closure is limited to only the western portion of Pond 1 as shown on Figure 3-3.

3.1.5 MSA 1E - Wet Closure/Chemical Fixation of Pond 1 - Eastern Portion

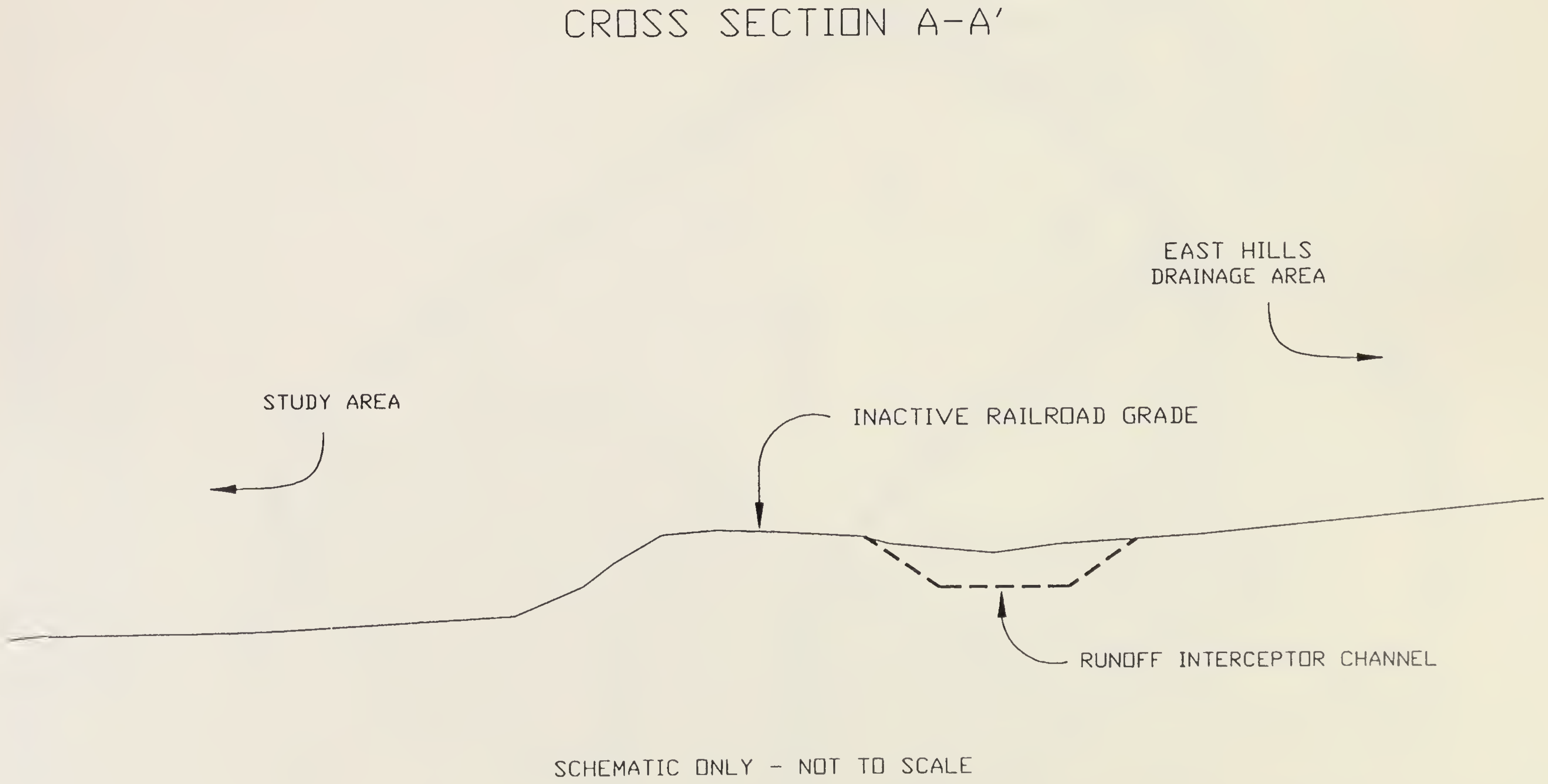
This media-specific action proposes isolating the eastern approximately one-third of Pond 1 tailings deposits and sediments by flooding (i.e., covering them with ponded water). Flooding is an appropriate option for closure of the tailings and pond bottom sediments within the eastern portion of Pond 1 since it will accomplish the primary remediation objectives of limiting human and terrestrial wildlife contact and eliminating the potential for airborne dispersal of tailings. Source controls to chemically fix metals within the tailings and associated soils will be incorporated in the wet-closure cells. Source controls will consist of the following: (1) application/mixing of lime with sediments before flooding and (2) circulation of high-pH water from Pond 2 through the wet-closure system. These controls will be supplemented by natural biological activity within the ponds. Details of the quantities, chemical forms, and application/mixing procedures for the liming, and assessment of the need for supplemental pH-control facilities would be addressed as part of Remedial Design.

The wet closure would be accomplished through the construction of low dikes. The eastern portion of Pond 1 will be flooded by shallow ponds in series (shown schematically as Ponds 1A and 1B on Figure 3-3) separated by a new dike. Small hydraulic structures (overflow weirs) will be incorporated into the separation dikes to maintain water surface elevation and circulate water between the ponds. The weirs will be designed to safely route flood flows from direct precipitation on the ponds through the wet-closure system.

Figure 3-4 presents a schematic section through the wet-closure cells and dikes. All dikes will be constructed sufficiently high to provide a minimum of two feet of freeboard on the normal water surface elevation in each pond. Adequate erosion protection will be incorporated on the upstream slope (and if necessary due to pond levels, the downstream slope) of each dike to provide protection against wave runup. Where the materials forming the foundation of a dike are weak and compressible, appropriate measures will be used to achieve a stable base. These measures may include over-excavation and replacement with suitable fill, or the use of geogrid materials to form a stable platform for dike construction.

3.2 Media-Specific Actions - Surface Water

Specific actions related to other media are intended to prevent potential metals loadings to surface water from runoff over soluble metal salts formed on exposed tailings surfaces. In



EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

EAST HILLS
INTERCEPTOR CHANNEL

Figure 3-2

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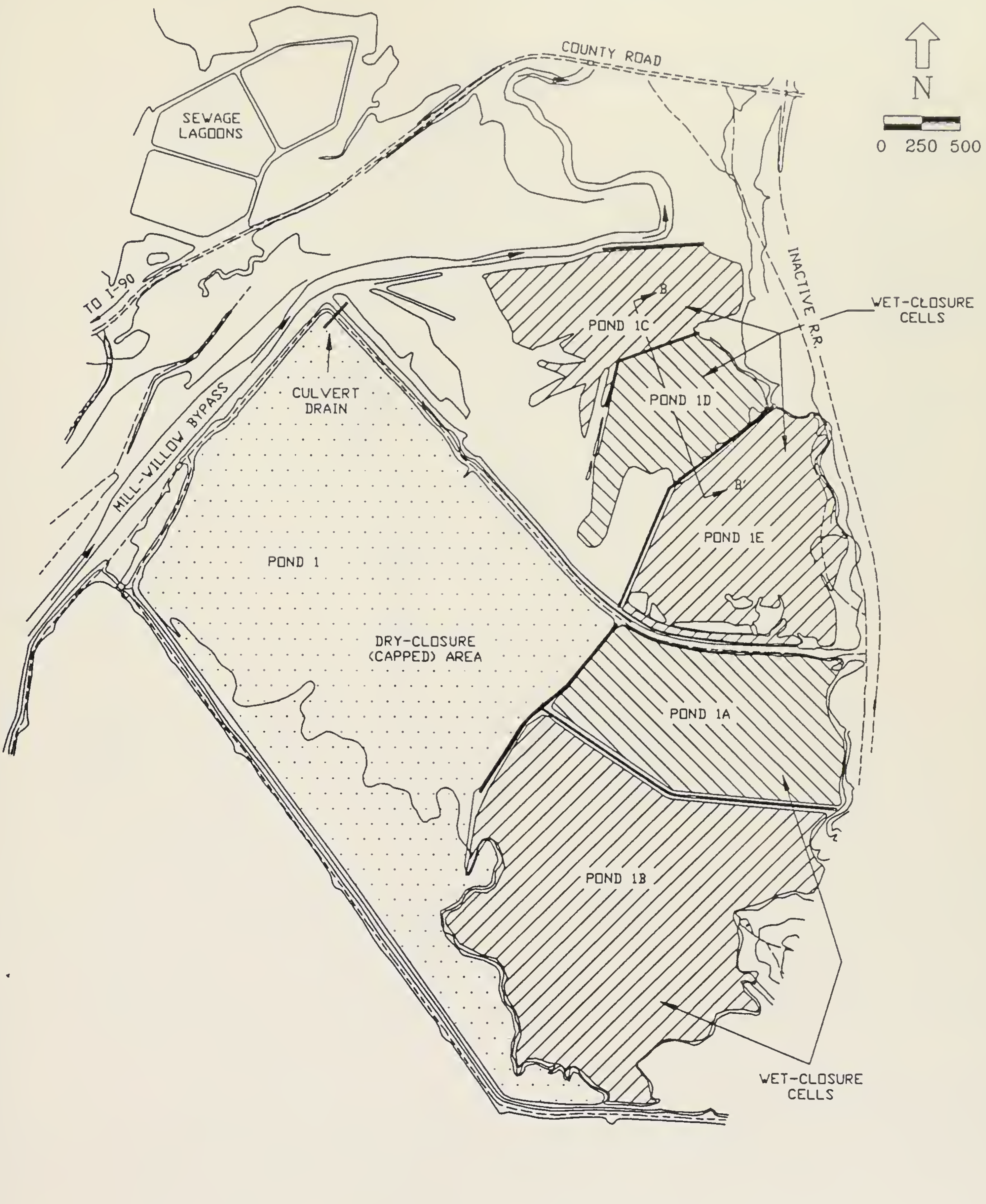
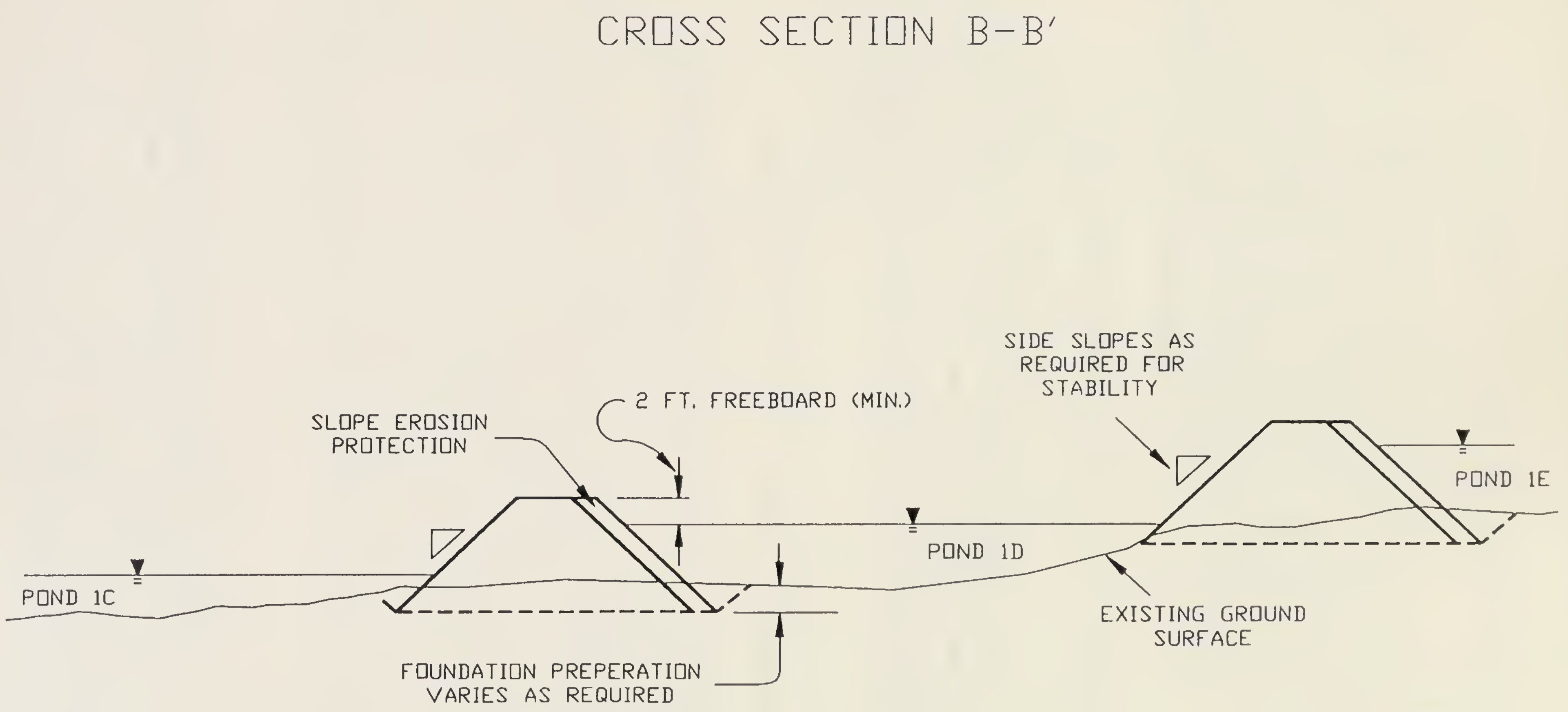


EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

MEDIA-SPECIFIC ACTIONS FOR WET CLOSURE WITHIN AND/OR BELOW POND 1

Figure 3-3

EP13-3.dwg



SCHEMATIC ONLY - NOT TO SCALE

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

TYPICAL WET CLOSURE
CELLS AND DIKES

Figure 3-4

EP13-4.dwg

addition, the actions proposed below will eliminate the potential for the erosion of in-place tailings and the resulting transport and deposition of eroded tailings in surface water offsite.

3.2.1 MSA 2A - Pond 1 Dike Extension - Area Below Pond 1

Design flood flows up to the 0.5 PMF from the Mill-Willow Bypass and Warm Springs Creek will be excluded from the area north of Pond 1 by the construction of a dike as shown on Figure 3-5. This dike will extend from the corner of the improved north-south Pond 1 dike to a point on the east side of the lower Silver Bow Creek channel. Excluding the design flood event in the Mill-Willow Bypass and Warm Springs Creek from the area below Pond 1 will prevent erosion and dispersal of the tailings and associated soils present there. Figure 3-6 shows the schematic configuration of the proposed dike extension. The dike will be protected from erosional scour by soil-cement armoring and toe embedment.

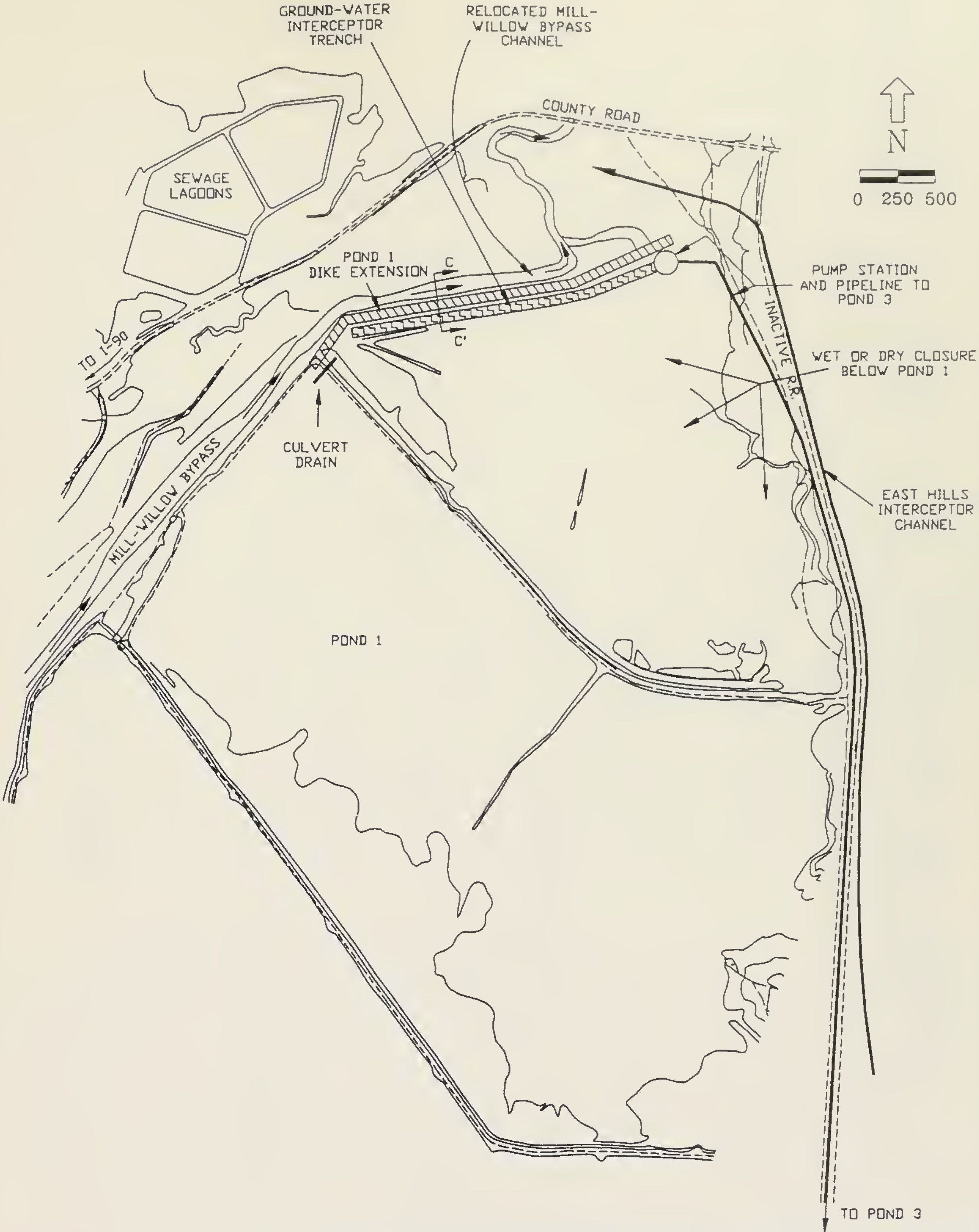
3.2.2 MSA 2B - East Hills Flood Interceptor Channel - Area Below Pond 1

This MSA is designed to protect the area below Pond 1 from 0.5 PMF design flood runoff from the hills to the east of the WSP Operable Unit. The improvements will consist of an extension to the north of the interceptor channel described under MSA 1C. This channel would discharge to Silver Bow Creek downstream of the Pond 1 dike extension (see MSA 2A) and will completely protect the area from erosion and flooding caused by high precipitation events (see Figure 3-5).

3.3 Media-Specific Actions - Tailings and Associated Soils

The tailings and associated soils below Pond 1 occur primarily within and adjacent to the lower channel of Silver Bow Creek and were likely deposited before the ponds were constructed. As discussed previously in Section 2.3.1, the estimated area and volume of tailings and associated soils between the Pond 1 dike and the existing Mill-Willow Bypass ranges from 63 acres and 390,600 cubic yards as extrapolated from the ROD to 70 acres and 283,000 cubic yards from this study. The average depth of tailings and associated soils as estimated in this study is about 2.5 feet. Natural fine-grained soils are present beneath the tailings and associated soils to an average depth of about five feet, where the sand and gravel aquifer unit is encountered. Both the tailings and associated soils and the immediately underlying uncontaminated soils are loose, largely saturated and predominantly fine-grained. An additional approximately 10,000 cubic yards of metals-bearing bottom sediments are estimated to be present within man-made channels below Pond 1.

Relatively minor quantities of tailings and associated soils have been identified along and within the Mill-Willow Bypass downstream of the portion of the channel addressed under the Mill-Willow Bypass Removal Action. Removal of these tailings and associated soils are addressed separately from the remediation for Pond 1 and the area below in the FS and ROD. Thus, in order to maintain a valid comparison between alternatives, these materials are not specifically addressed in this study, and no MSA has been developed for them. Tailings associated with the Mill-Willow Bypass below Pond 1 will, however, be remediated in a manner consistent with the Bypass Removal Action.

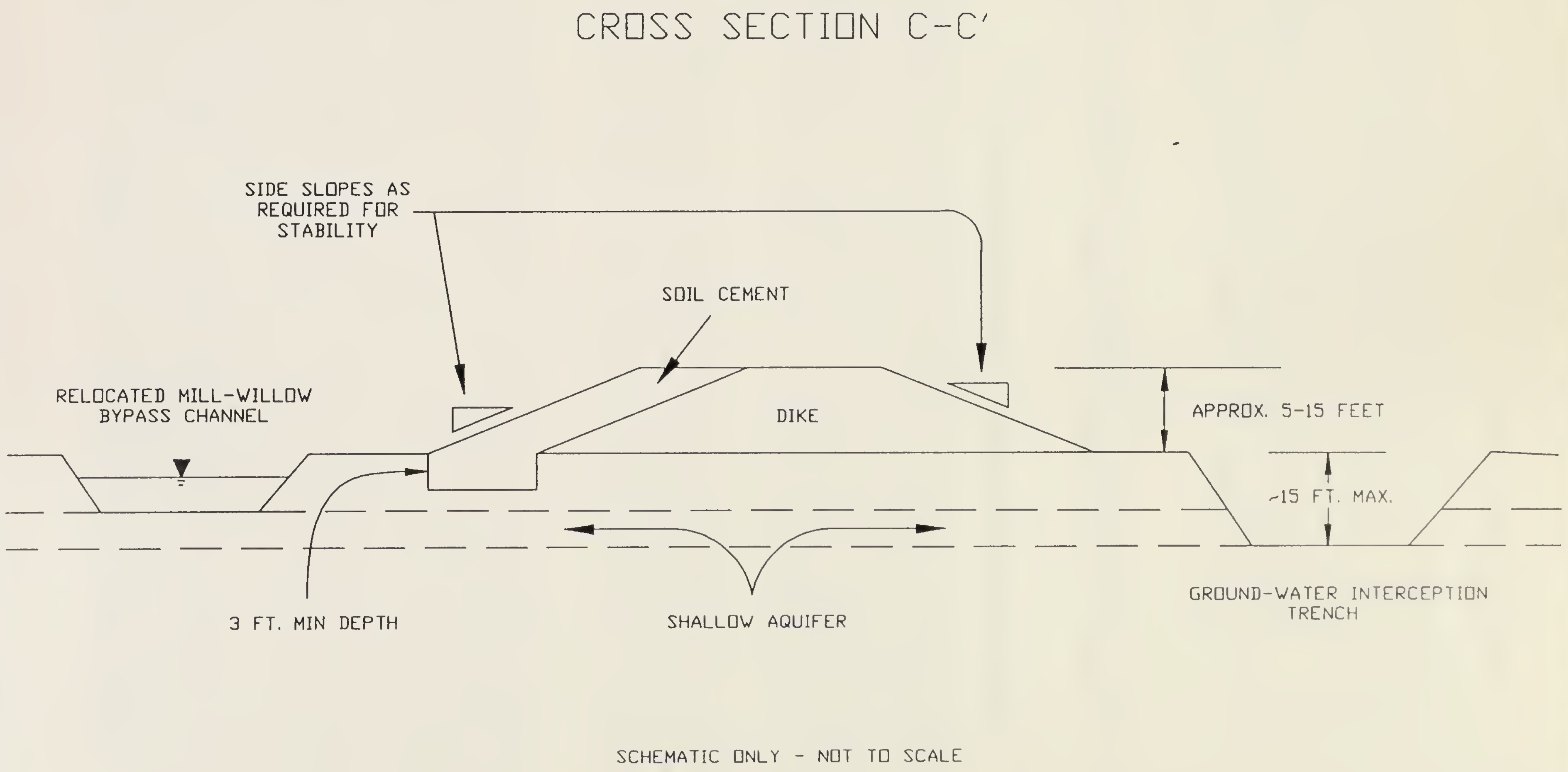

GROUND-WATER INTERCEPTOR TRENCH
RELOCATED MILL-WILLOW BYPASS CHANNEL
COUNTY ROAD
N
0 250 500
SEWAGE LAGOONS
POND 1 DIKE EXTENSION
C
C'
PUMP STATION AND PIPELINE TO POND 3
INACTIVE R.R.
WET OR DRY CLOSURE BELOW POND 1
TO I-90
CULVERT DRAIN
MILL-WILLOW BYPASS
EAST HILLS INTERCEPTOR CHANNEL
POND 1
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

MEDIA–SPECIFIC ACTIONS RELATED TO WET OR DRY CLOSURE BELOW POND 1

Figure 3–5

EP13-5.dwg


CROSS SECTION C–C′
SIDE SLOPES AS REQUIRED FOR STABILITY
SOIL CEMENT
RELOCATED MILL-WILLOW BYPASS CHANNEL
DIKE
APPROX. 5-15 FEET
~15 FT. MAX.
3 FT. MIN DEPTH
SHALLOW AQUIFER
GROUND-WATER INTERCEPTION TRENCH
SCHEMATIC ONLY - NOT TO SCALE

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

FLOOD PROTECTION DIKE, GROUND–WATER INTERCEPTION TRENCH AND RELOCATED M–W BYPASS CHANNEL

Figure 3–6

EP13-6.dwg

3.3.1 MSA 3A - Wet Closure/Chemical Fixation - Area Below Pond 1

This media-specific action proposes isolating tailings deposits located below Pond 1 by flooding them and keeping them covered with water. The flooding of tailings would be accomplished through the construction of a series of low dikes designed to inundate the tailings located in this area. The approximate location and schematic configuration of the wet-closure cells and dikes are shown in Figures 3-3 and 3-4, respectively. Those tailings and associated soils which would not be flooded (in particular, the trench bottom sediments described in Section 2.3.1) would be excavated, consolidated and capped in the dry-closure area within the western portion of Pond 1.

Source controls will be incorporated in the wet-closure cells in the same manner as described under MSA 1E, except that the high-pH feed water would flow from the Pond 1 wet closure.

3.3.2 MSA 3B - Remove Tailings and Associated Soils -Area Below Pond 1

This MSA includes the excavation and removal of tailings and associated soils from the area below Pond 1 to the existing Mill-Willow Bypass as shown on Figure 3-1. These materials would be excavated and transported for disposal in the dry-closure area within Pond 1. This MSA also includes the restoration of excavated areas by covering such areas with approximately six inches of borrow material obtained from sources immediately east of the site, phosphate conditioning of this material, and seeding of the entire area with appropriate grass seed mixtures.

This MSA will also include a dewatering and sediment control element which would be necessary during construction to facilitate excavation and minimize the potential for sediment releases to the Clark Fork River during excavation. Discharges from the dewatering operation would be pumped to Pond 1 for evaporation of the water and dry closure of the sediment.

Recent experience gained in completing the Mill-Willow Bypass Removal Action and foundation excavation at the toes of the Pond 2 and 3 Dams demonstrates that significantly greater quantities than those estimated for just the tailings and associated soils and trench bottom sediments would have to be excavated to achieve complete removal. Regardless of the specific excavation technique used, the loose, saturated tailings and underlying fine-grained materials become slurry-like when disturbed. Although dewatering would be implemented, it would not be capable of significantly reducing the degree of saturation in the fine-grained soils. Thus, the process of removing the tailings and associated soils may unavoidably contaminate the underlying non-contaminated material and require that it also be removed. Complete removal is only achievable when the competent, coarse-grained sand and gravel aquifer unit is encountered. Based on the average depth to the sand and gravel unit, it is estimated that approximately double the volume of the tailings and associated soils and bottom sediments will actually have to be excavated to achieve complete removal. For purposes of this evaluation, it is assumed that about 590,000 cubic yards of material would be excavated.

3.3.3 MSA 3C - Dry Closure Area Below Pond 1

This MSA consists of covering all exposed tailings and associated soils in the area below Pond 1 with 12 inches of random fill, two inches of crushed limestone, and six inches of topsoil. The area would then be fertilized and seeded. The area would be graded to prevent ponding of rainfall on top of the dry-closed area. A permanent trench drain would be excavated along the lower Silver Bow Creek channel through the dry-closure area. This drain would be used for construction and long-term dewatering of the area. It would be excavated at least 2-3 feet into the underlying shallow aquifer to facilitate gravity drainage of the tailings and associated soils. Contaminated soils encountered in excavation of the drain would be incorporated in the adjacent dry closure.

3.4 Media-Specific Actions - Ground Water

Ground water will be intercepted by trench drains and recirculated to the upgraded WSP system for treatment prior to discharge to the Mill-Willow Bypass. Three different configurations have been developed to meet this requirement and are presented as MSAs 4A, 4B and 4C. MSA 4A, as developed in the FS, is intended to lower the potentiometric surface of the shallow aquifer underlying Pond 1 (and a small portion of the area below Pond 1) beneath the base of the tailings and/or pond bottom sediments and to intercept ground water flowing downgradient (i.e., to the north) of the Pond 1 dike. The primary objective of MSA 4B is to form a hydraulic barrier downgradient of Pond 1 at the existing Mill-Willow Bypass to prevent any potential future off-site releases of ground water which exceeds MCLs. MSA 4C is a ground-water interception trench located along the entire downstream toe of the east-west Pond 1 dike to intercept ground water flowing north of the Pond 1 dike.

3.4.1 MSA 4A - Ground-Water Interception and Pumpback System - Pond 1

This MSA, as developed in the FS, would provide for lowering the potentiometric surface of the shallow aquifer beneath Pond 1, and collection and treatment of the intercepted ground water (including ground water which would drain from the base of tailings/pond bottom sediments within and below Pond 1). It would include a ground-water interception trench within and immediately below Pond 1, and a pump station and pipeline capable of pumping intercepted ground water back to Pond 3 for treatment (see Figure 3-1).[9]

3.4.2 MSA 4B - Ground-Water Interception and Pumpback System - Below Pond 1

This MSA provides for a hydraulic barrier downgradient of Pond 1 to prevent offsite migration of ground water in the shallow aquifer or as discharge to surface waters. The hydraulic barrier would be formed by excavation and pumping of a trench located approximately

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[9] If this action is required as part of the remedy for Pond 1 and the area below Pond 1, ARCO proposes that the feasibility of pumping recovered ground water to Pond 2 (as opposed to Pond 3) for treatment be investigated during Remedial Design.

as shown on Figure 3-5. The existing Mill-Willow Bypass channel would be utilized to the maximum extent feasible to minimize required excavation. It is assumed for purposes of this study that the trench would fully penetrate the shallow sand and gravel aquifer (see Figure 3-6). Final design analyses would examine the feasibility of a partially-penetrating trench to ensure a fully-effective hydraulic barrier. A pump station and pipeline will be included to return intercepted ground water to Pond 3 for treatment.[10] This system will be designed to accommodate both anticipated ground-water flows, and wet-closure circulation flows which may at times exceed evapotranspiration and minor seepage losses (for those alternatives incorporating wet closures).

3.4.3 MSA 4C - Ground-Water Interception and Pumpback System - Toe of Pond 1 Dike

This MSA consists of a ground-water interception trench constructed immediately below the Pond 1 dike. The existing trench at the downstream toe of the dike would be deepened along its entire length to fully penetrate the sand and gravel aquifer, or a new trench on a parallel alignment just downstream would be excavated. Final selection of the location of the trench would be coordinated with stabilization of the Pond 1 east-west dike under Remedial Design. The purpose of this trench would be to intercept any contaminated ground water flowing downgradient from Pond 1. Water collected in this trench would be pumped to Pond 3 for treatment.[11]

3.4.4 MSA 4D - Mill-Willow Bypass Replacement Channel

As discussed above under MSA 4B, a portion of the existing Mill-Willow Bypass channel below Pond 1 would be incorporated into the proposed downgradient ground-water interception trench. Thus, this portion of the Bypass would have to be replaced. The replacement channel would be located approximately as shown on Figure 3-5. The base of the new channel would be excavated to the top of the shallow sand and gravel aquifer, and grade-control structures installed as necessary to achieve a stable channel. The schematic alignment shown is intended to minimize the potential for interference with a shallow buried high-pressure gas pipeline traversing the area between the Bypass and Warm Springs Creek. Suitable materials excavated as part of channel construction may be utilized as borrow for construction of the adjacent flood-protection dike. Any tailings and associated soils excavated incidental to channel construction would be transported to Pond 1 for dry closure.

4.0 DEVELOPMENT OF ALTERNATIVES

The remedial alternatives are assembled by combining the various appropriate media-specific actions to form a comprehensive plan of remedial actions. Combination of remedial concepts involving full dry closure versus wet and dry closure within Pond 1 and removal, wet

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[10] See footnote 9.

[11] See footnote 9.

closure or dry closure below Pond 1 results in a total of six action alternatives plus the No Action alternative. These alternatives represent all of the possible combinations of the media-specific actions to remediate the area within and below Pond 1. Table 4-1 is a summary of the MSAs which make up each alternative. Each of the alternatives is briefly described in the following paragraphs.

TABLE 4-1

ALTERNATIVES/MEDIA SPECIFIC ACTIONS

ALTERNATIVE	MEDIA SPECIFIC ACTIONS													
	1 A	1 B	1 C	1 D	1 E	2 A	2 B	3 A	3 B	3 C	4 A	4 B	4 C	4 D
NO. 1	X	X	X						X		X			
NO. 2	X	X	X			X	X	X			X	X		X
NO. 3	X	X	X			X	X			X	X	X		X
NO. 4	X		X	X	X				X				X	
NO. 5	X		X	X	X	X	X	X				X		X
NO. 6	X		X	X	X	X	X			X		X		X
NO. 7 (NO ACTION)														

4.1 Alternative No. 1 (Dry Close Pond 1, Remove Below Pond 1)

This alternative consists of: draining the wet areas within Pond 1, and capping/covering (dry closing) all tailings and associated soils and pond bottom sediments located within the pond; constructing a ground-water dewatering/interception trench system within and immediately below the pond; constructing a flood runoff interceptor channel in the east hills above the pond; lowering and modifying the east-west Pond 1 dike; and removing all tailings below Pond 1 to the Mill-Willow Bypass for dry closure within Pond 1. The major components of Alternative No. 1 are shown on Figure 4-1.

4.2 Alternative No. 2 (Dry Close Pond 1, Wet Close Below Pond 1)

This alternative includes all of the actions described under Alternative No. 1, except for removal of tailings and associated soils below Pond 1 (see Figure 4-2). In addition, the following actions would be implemented: construction of low dikes in the area below Pond 1 to

provide for flooding of all exposed tailings; construction of a flood interceptor channel below Pond 1 to intercept flood flow originating in the hills east of the site; construction of a north extension of the Mill-Willow Bypass flood protection dike; construction of a ground-water interception trench at the lower end of the area below Pond 1, along with associated pumping equipment and pipe necessary to pump the intercepted ground water back to Pond 3; and construction of a replacement for a portion of the existing Mill-Willow Bypass channel utilized for the ground-water interception trench.

4.3 Alternative No. 3 (Dry Close Pond 1, Dry Close Below Pond 1)

This alternative is the same as Alternative No. 1 for Pond 1, but considers covering/capping the tailings located below Pond 1 rather than removal. In addition to the actions indicated for Pond 1 in Alternative No. 1, this alternative would require: dry closure of tailings and associated soils below Pond 1; construction of a downgradient ground-water interception trench and the associated return flow pumping and piping system; replacement of a portion of the existing Mill-Willow Bypass channel; extension of the flood protection dike along the Mill-Willow Bypass; and construction of the east hills flood interceptor channel required for protection of the area below Pond 1. Figure 4-3 illustrates the major components of Alternative No. 3.

4.4 Alternative No. 4 (Wet/Dry Close Pond 1, Remove Tailings Below Pond 1)

This alternative proposes a combination of dry and wet closure for the western and eastern portions, respectively, of Pond 1, and removal of all tailings below Pond 1 as illustrated on Figure 4-4. Implementation of this alternative with respect to Pond 1 will also require: stabilization of the east-west dike of Pond 1 against earthquake loadings; construction of the east hills interceptor channel to protect Pond 1; and a ground-water interception system immediately below Pond 1, along with the related pumpback facilities.

4.5 Alternative No. 5 (Wet/Dry Close Pond 1, Wet Close Below Pond 1)

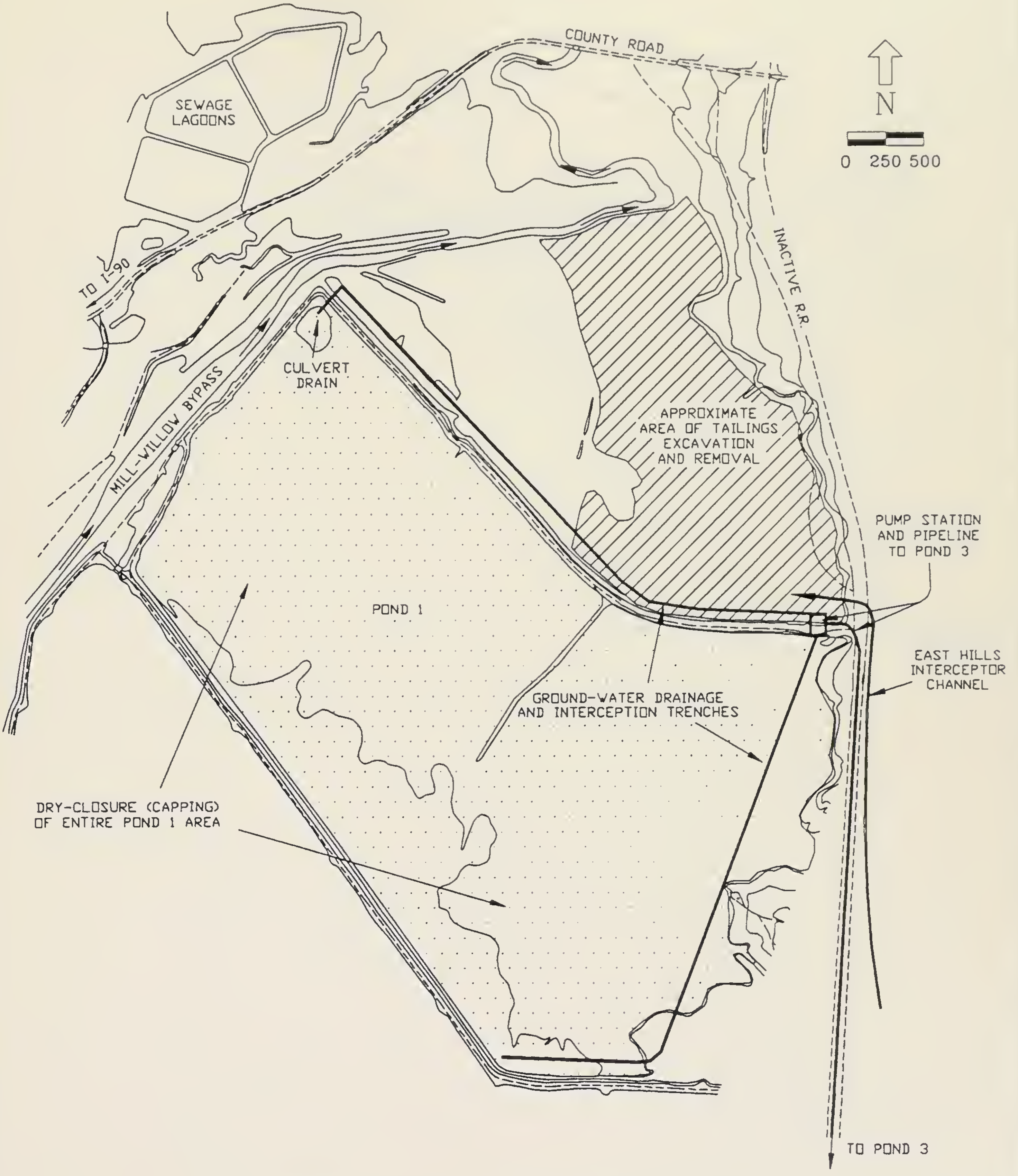
Pond 1 is dealt with in the same way as in Alternative No. 4. Wet closure of the area below Pond 1 involves the same actions as for Alternative No. 2. The major components of Alternative No. 5 are shown on Figure 4-5.

4.6 Alternative No. 6 (Wet/Dry Close Pond 1, Dry Close Below Pond 1)

Pond 1 is dealt with in the same way as Alternative No. 4. Dry closure of the area below Pond 1 is the same as for Alternative No. 3. Figure 4-6 illustrates the major components of Alternative No. 6.

4.7 Alternative No. 7 (No Action)

Alternative No. 7 is the No Action alternative required under CERCLA and is used as a baseline against which the other alternatives are evaluated.

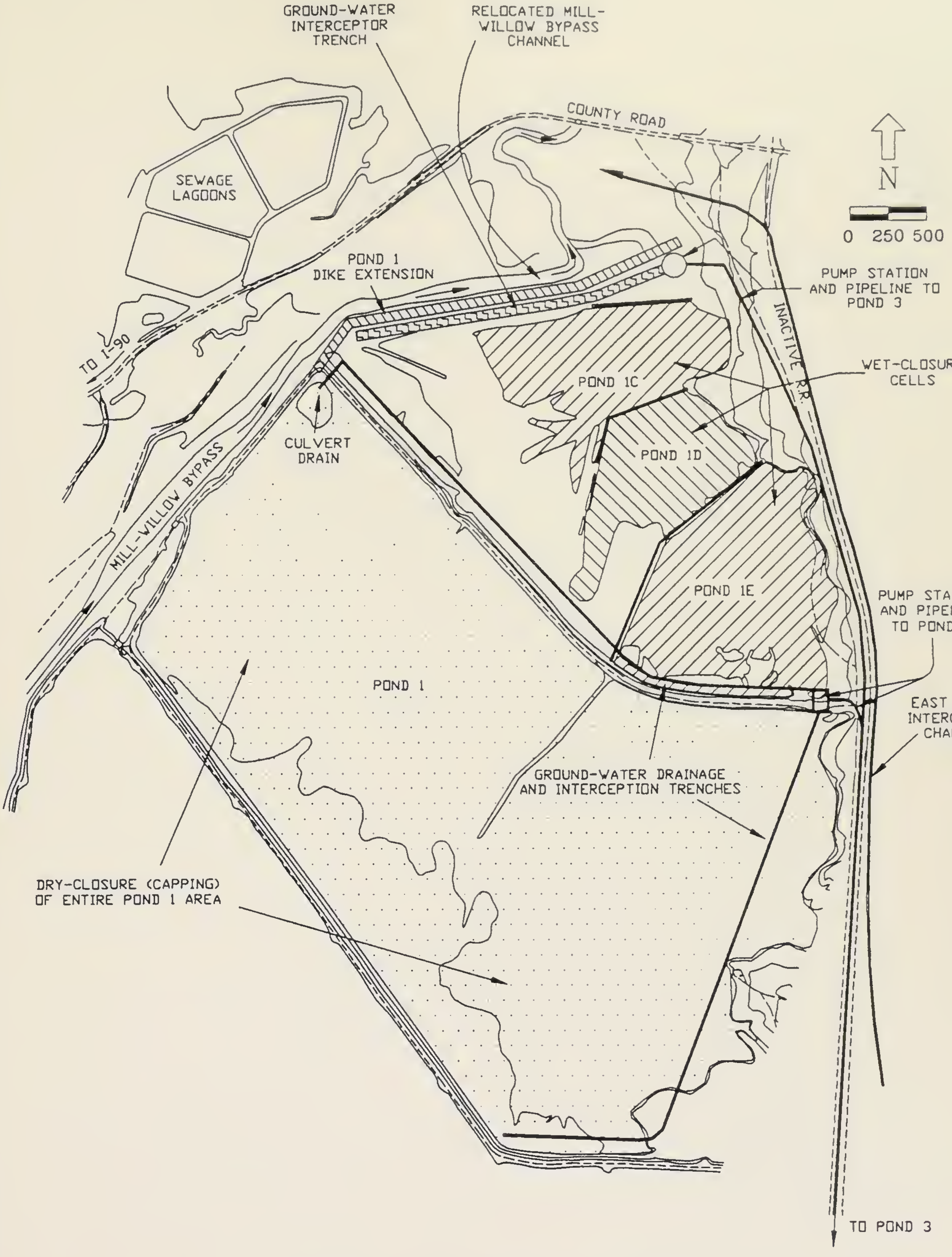

COUNTY ROAD
N
0 250 500
SEWAGE LAGOONS
TO I-90
INACTIVE R.R.
MILL-WILLOW BYPASS
CULVERT DRAIN
APPROXIMATE AREA OF TAILINGS EXCAVATION AND REMOVAL
PUMP STATION AND PIPELINE TO POND 3
POND 1
EAST HILLS INTERCEPTOR CHANNEL
GROUND-WATER DRAINAGE AND INTERCEPTION TRENCHES
DRY-CLOSURE (CAPPING) OF ENTIRE POND 1 AREA
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 1

Figure 4-1

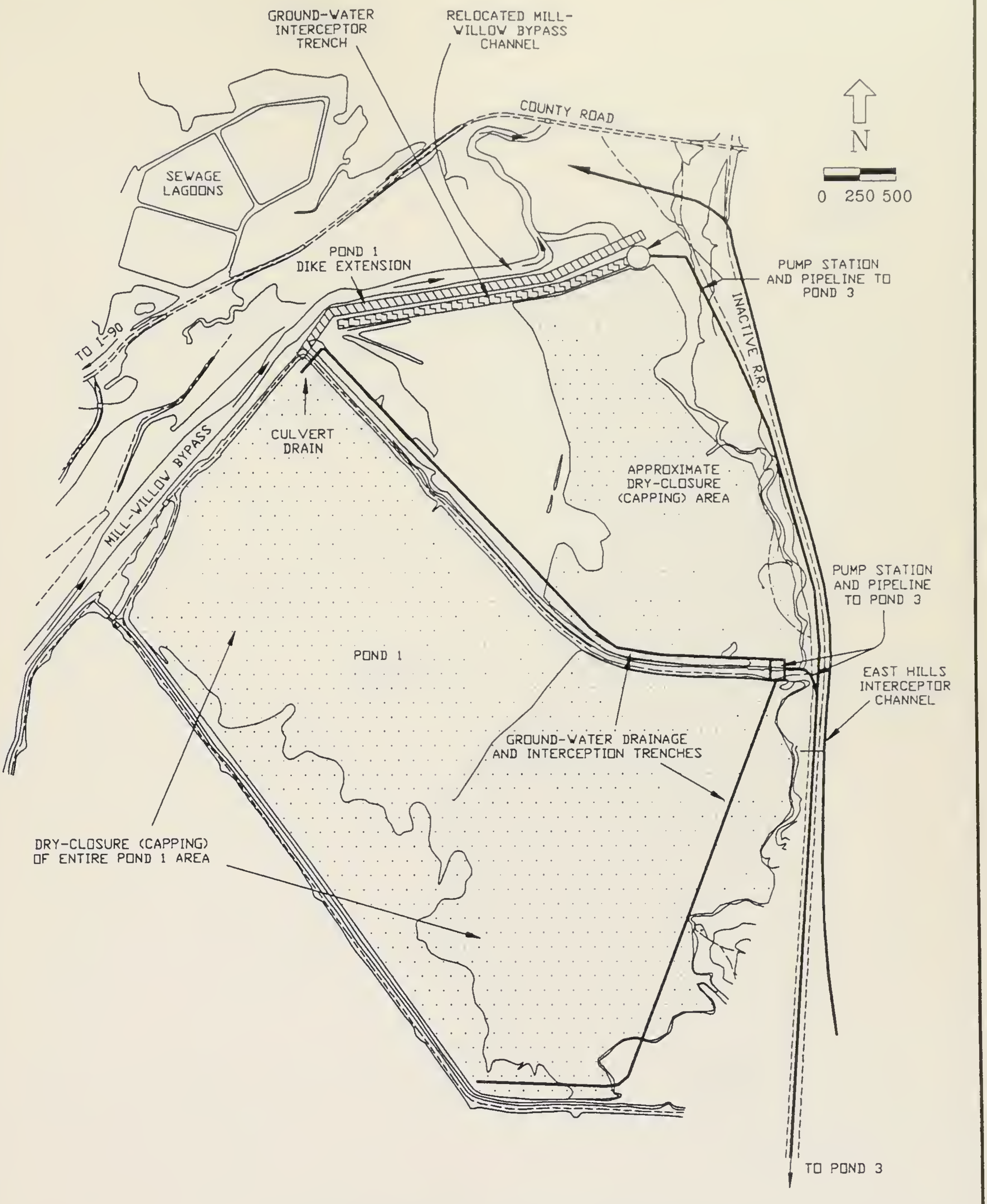
ALT1.dwg


GROUND-WATER INTERCEPTOR TRENCH
RELOCATED MILL-WILLOW BYPASS CHANNEL
COUNTY ROAD
N
0 250 500
SEWAGE LAGOONS
POND 1 DIKE EXTENSION
PUMP STATION AND PIPELINE TO POND 3
INACTIVE R.R.
WET-CLOSURE CELLS
TO I-90
POND 1C
POND 1D
CULVERT DRAIN
MILL-WILLOW BYPASS
POND 1E
PUMP STATION AND PIPELINE TO POND 3
POND 1
EAST HILLS INTERCEPTOR CHANNEL
GROUND-WATER DRAINAGE AND INTERCEPTION TRENCHES
DRY-CLOSURE (CAPPING) OF ENTIRE POND 1 AREA
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 2
Figure 4-2

ALT2.dwg

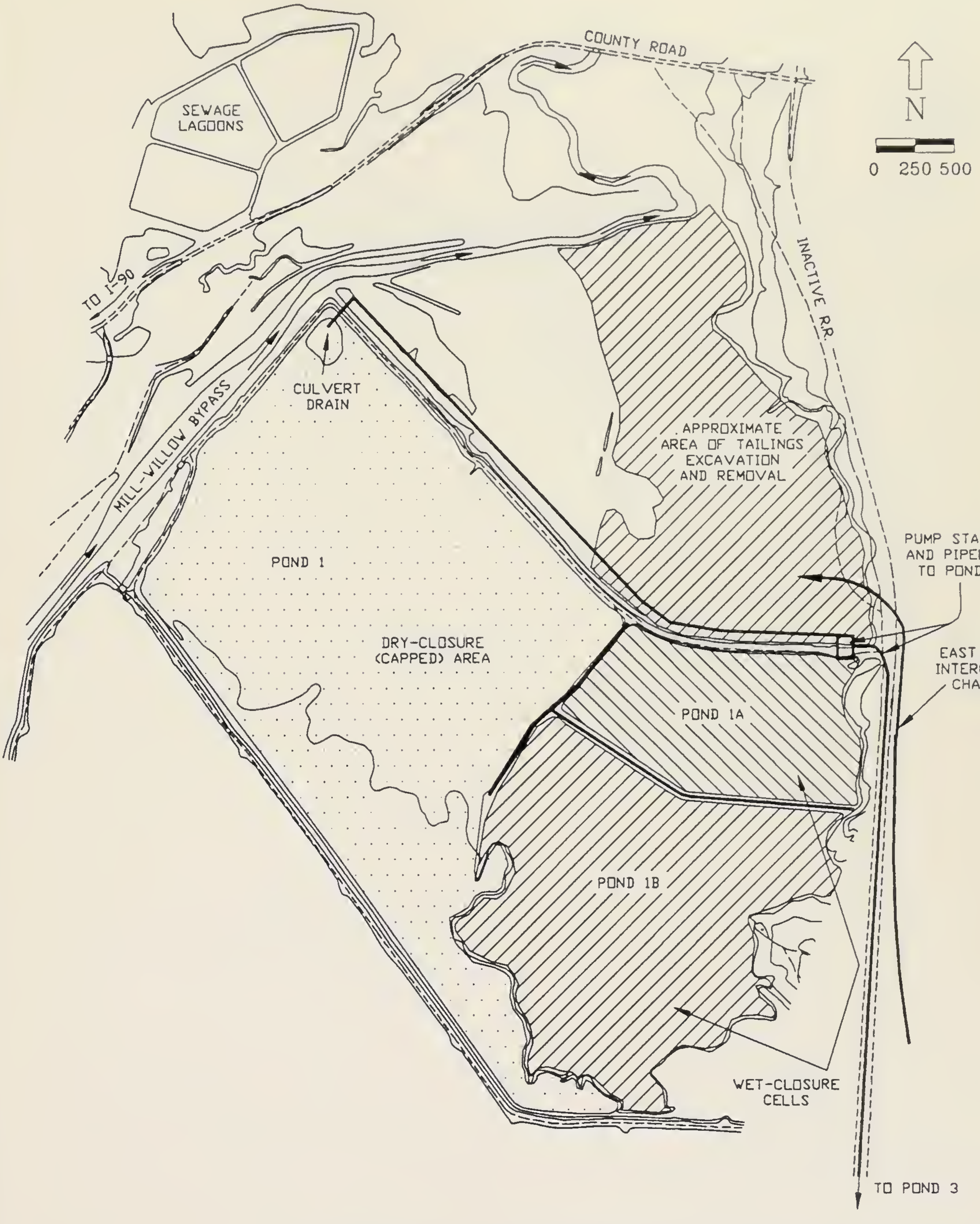

GROUND-WATER INTERCEPTOR TRENCH
RELOCATED MILL-WILLOW BYPASS CHANNEL
COUNTY ROAD
N
0 250 500
SEWAGE LAGOONS
POND 1 DIKE EXTENSION
PUMP STATION AND PIPELINE TO POND 3
INACTIVE R.R.
TO I-90
CULVERT DRAIN
MILL-WILLOW BYPASS
APPROXIMATE DRY-CLOSURE (CAPPING) AREA
PUMP STATION AND PIPELINE TO POND 3
POND 1
EAST HILLS INTERCEPTOR CHANNEL
GROUND-WATER DRAINAGE AND INTERCEPTION TRENCHES
DRY-CLOSURE (CAPPING) OF ENTIRE POND 1 AREA
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 3

Figure 4–3

ALT3.dwg

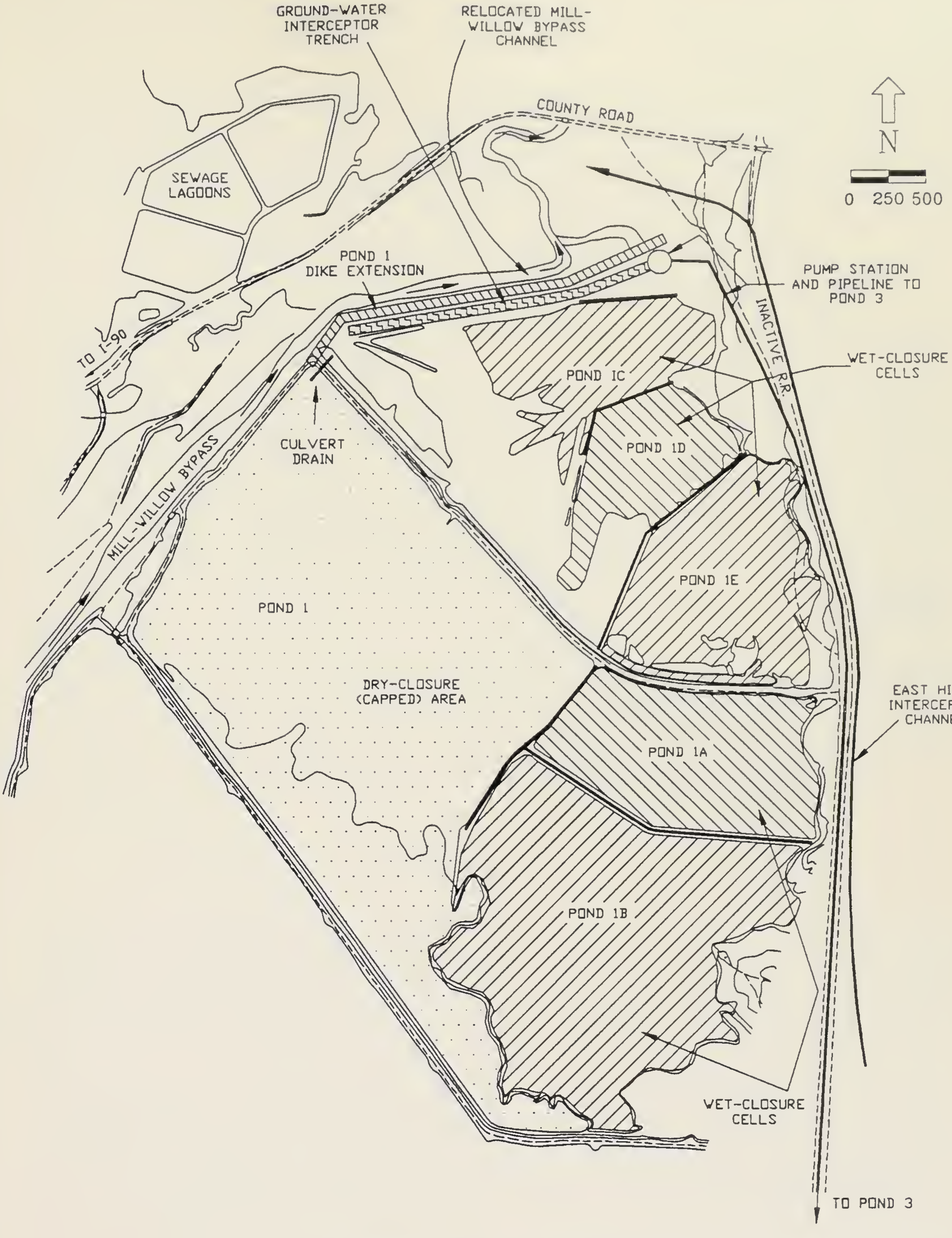

COUNTY ROAD
N
0 250 500
SEWAGE LAGOONS
TO I-90
INACTIVE R.R.
CULVERT DRAIN
MILL-WILLOW BYPASS
APPROXIMATE AREA OF TAILINGS EXCAVATION AND REMOVAL
PUMP STATION AND PIPELINE TO POND 3
POND 1
DRY-CLOSURE (CAPPED) AREA
EAST HILLS INTERCEPTOR CHANNEL
POND 1A
POND 1B
WET-CLOSURE CELLS
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 4

Figure 4–4

ALT4.dwg

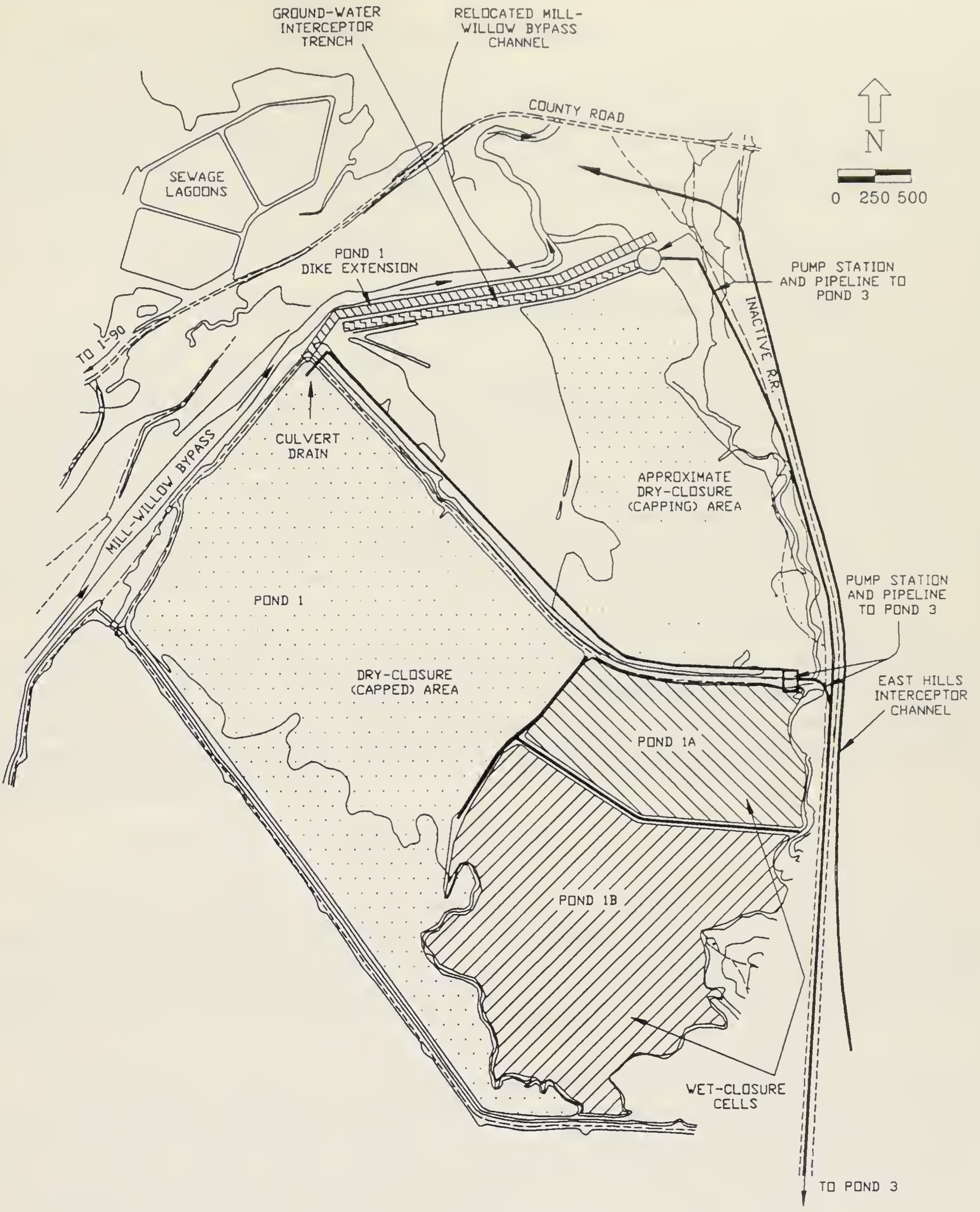


EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 5

Figure 4–5

ALT5.dwg


GROUND-WATER INTERCEPTOR TRENCH
RELOCATED MILL-WILLOW BYPASS CHANNEL
COUNTY ROAD
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SEWAGE LAGOONS
POND 1 DIKE EXTENSION
PUMP STATION AND PIPELINE TO POND 3
INACTIVE R.R.
TO I-90
CULVERT DRAIN
MILL-WILLOW BYPASS
APPROXIMATE DRY-CLOSURE (CAPPING) AREA
POND 1
PUMP STATION AND PIPELINE TO POND 3
DRY-CLOSURE (CAPPED) AREA
EAST HILLS INTERCEPTOR CHANNEL
POND 1A
POND 1B
WET-CLOSURE CELLS
TO POND 3

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

REMEDIATION PLAN
ALTERNATIVE NO. 6

Figure 4-6

ALT6.dwg

5.0 INDIVIDUAL ANALYSIS OF ALTERNATIVES

This section presents an analysis of the alternatives developed in Section 4.0 for seven of the nine NCP evaluation criteria.[12] The remaining two modifying criteria, state and community acceptance of the alternatives for remedial action, will be addressed by EPA in the ROD for Pond 1 and the area below following the period for public review and comment.

5.1 Alternative No. 1 (Dry Close Pond 1, Remove Below Pond 1)

5.1.1 Overall Protection of Human Health and the Environment

Covering all tailings within Pond 1 with an earthen protective cap will prevent human and environmental exposure to these materials. Protection of the entire area from flooding up to the 0.5 PMF will be provided by constructing a flood interceptor channel and an armored dike on the east and west sides of the Pond, respectively. The existing earthen dikes will be stabilized and lowered to minimize the potential for earthquake-induced failure. Construction of the ground-water interception trench along the toe of the Pond 1 dike will prevent migration of upgradient ground water offsite. Covering the tailings and associated soils and pond bottom sediments will eliminate the potential for airborne migration of contaminants.

Removal of the tailings from below Pond 1 and placing them in Pond 1 will eliminate any potential for human or environmental exposure in the area below Pond 1. It also eliminates any potential for migration of the tailings and associated soils through any natural action, at least when only considering the area from within which the tailings are to be removed. The tailings and associated soils will continue to exist. However, they will exist only in combination with those already present within Pond 1.

5.1.2 Compliance with ARARs

The most significant state and federal ARARs identified in the ROD related to management of pond bottom sediments are the Montana Dam Safety Act, the Montana Floodplain and Floodway Management Act, the Montana Solid Waste Act, and implementing regulations under each. In terms of this evaluation, the significant elements of the dam safety ARAR are flood and earthquake design criteria. This alternative meets all criteria.

There are no ARAR'S for tailings and associated soils. However, the removal contemplated would be consistent with the protocols established for the Mill-Willow Bypass Removal Action. This protocol is appropriate for identification of tailings and associated soils in the area below Pond 1 and is based on a consistent correlation between the characteristic visual attributes associated with tailings and associated soils, and levels of metals concentrations in the soil profile. Texture and position may be used as secondary criteria for the identification of tailings. Confirmation sampling and analysis performed as part of the Mill-Willow Bypass Removal Action indicate that concentrations for target metals approach background levels in areas of the Bypass where tailings and associated soils have been excavated following the soils

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[12] 40 C.F.R. 300.430(e)

removal protocol. The protocol and preliminary results for the Bypass Removal Action are discussed in Section 7.3.

MCLs have been adopted by the State of Montana as water quality standards for Class II ground water, and are listed in the ROD[13]. Since this alternative is designed to intercept any contaminated ground water before it leaves the site by capturing the water in the proposed interceptor trench and pumping it to Pond 3 for treatment, it is expected that this alternative will meet ground-water quality ARARs.

The ROD lists specific ambient and point source surface water quality standards, monitoring requirements, and other state and federal requirements for surface water remedial action. These requirements are not directly related to selection of a remedy for Pond 1 and the area below Pond 1, as no direct surface-water discharge is expected to result from implementation of this alternative. Consequently, it can be concluded that this alternative will meet all surface-water ARARs.

5.1.3 Long-Term Effectiveness And Permanence

Magnitude of Residual Risk. Residual risks remaining after the dry closure of Pond 1 relating to the potential for human or environmental exposure to tailings or pond bottom sediments are minimal. Removal below Pond 1 is permanent and carries no residual risk. Little potential exists for failure of the Pond 1 cap in a manner which would increase the exposure potential. Some maintenance will be required to insure that excessive differential settlement is corrected as it occurs. A potential for redistribution of tailings due to flooding is highly unlikely as the entire Pond 1 area is fully protected up to the 0.5 PMF event. Similarly, remedial dike design would ensure that an earthquake up to the MCE would not result in a catastrophic failure.

Lowering the water table within Pond 1 to facilitate dry closure will result in induced downward drainage of tailings pore water over a very long period of time. Furthermore, their is a potential that the dewatering may not completely eliminate the interface between the lower portion of the tailings and the underlying ground water due to irregularity of the depth of tailings and variations in permeability. Even where the water table is drawn down below the base of tailings into underlying fine-grained soils, a capillary zone will exist creating hydraulic connection between the tailings and the underlying aquifer. Although these potential tailings/ground-water connections cannot be quantified, the potential for a continuing limited flux of contamination to the ground water exists within the site. At this time, it is not possible to predict how long this condition may persist, or the potential for resulting exceedances of MCLs, due to the variability and complexity of the ground-water chemistry and hydraulic conditions. However, the interception system will prevent off-site migration of contaminated ground water for as long as necessary to meet ARARs.

Residual risks relating to surface water are also minimized. The facilities are designed to reduce the potential for either wind or water erosion which might result in the ultimate contamination of surface water.

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[13] Attachment to Part II, p. 3

Adequacy of Controls. Very few controls are associated with this remedial alternative. Interception of ground water for treatment involves the continuing use of mechanical equipment which is very simple to control and operate. All other features of the plan do not require an operational element as it would typically be considered. Access controls are limited in nature and relate primarily to potential recreational uses of the site. With the exception of the mechanical equipment associated with the ground-water interception system, no other aspect of the alternative involves the use of methods which have a limited useful life. This does not mean that periodic maintenance is not required, but rather that the system is capable of serving its stated objective for an indefinite period of time without the need for stringent controls of any type. Institutional controls are necessary to ensure that no wells are installed in the remediated area unless or until monitoring results verify consistent compliance with ARARs.

5.1.4 Reduction Of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. This alternative does not utilize a "treatment process" per se, except for the ground-water interception and pumpback for treatment through Pond 3. Pond bottom sediments, tailings and associated soils, and surface water are all dealt with through the construction of permanent physical modifications to the site. Treatment of recovered contaminated ground water is accomplished by returning the flow to Pond 3.

Amount of Material Treated or Destroyed. None of the tailings and associated soils or pond bottom sediments which exist on the site will be treated or destroyed. Only intercepted ground water will be treated in the upgraded WSP system. Existing contaminated material will be consolidated into a smaller area than presently exists and covered to prevent human and environmental contact.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. No significant reductions in toxicity or volume result as a consequence of implementation of this alternative. The toxicity of a very small volume of metals in ground water treated in Pond 3 will be reduced, but the reduction is insignificant in view of the total volume of metals present within the Operable Unit. The total surface area of tailings and associated soils and pond bottom sediments within the site is reduced, but the volume remains unchanged. The potential for mobility of these materials due to wind erosion, flooding, or earthquakes is reduced to insignificant levels. Mobility of metals and any other contaminants to the underlying ground water may increase due to the lowering of the water table within the areas directly underlying the pond bottom sediments.

Degree to Which Treatment is Irreversible. Treatment, other than pumping of ground water to Pond 3, is not proposed as part of this alternative. Precipitation of metals in Pond 3 is expected to be essentially irreversible due to the maintenance of high pH, non-oxidizing conditions.

Type and Quantity of Residuals Remaining. Treatment of intercepted ground water will result in residual insoluble metals precipitates in Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.1.5 Short Term Effectiveness

Protection of Community During Remedial Actions. Risks to the community during implementation would be limited and relatively insignificant. Through the use of appropriate measures during the construction process, dust would be effectively controlled so as not to affect the surrounding area. Increased traffic during construction can be expected. A potential for releases of contaminated water or sediments to the Clark Fork River will exist during the removal process. However, this potential will be minimized through the use of appropriate structural controls constructed during the implementation phase.

Protection of Workers During Remedial Actions. Exposure of workers to contaminated materials during the remediation process is possible. These risks can be reduced to acceptable levels through the use of appropriate protective clothing and equipment, as well as by the implementation of management and worker training programs. All workers will be required to have completed 40 hours of formal health and safety training.

Environmental Impacts. Environmental impacts will be very significant for this alternative. Removal of all tailings and associated soils below Pond 1 will necessarily result in the total destruction of all vegetation and wetlands which presently exist within the area. This damage will be relatively permanent, at least as it relates to the potential to reconstruct the wetlands environment which presently exists. Removal of all contaminated materials will result in the removal of the relatively impermeable materials which presently overlay the shallow aquifer, resulting in a situation which will not be conducive to constructing or rebuilding a wetlands-type environment. The reclaimed area within which removal occurs would become grassland habitat in place of the existing wetlands aquatic/waterfowl habitat.

Dry closure of Pond 1 will also have a significant impact on the existing wetlands environment which exists in the eastern third of the pond. The resulting dry-closed area will not be nearly as attractive to wildlife and waterfowl as the existing wetland. A positive impact will result in the western portion of Pond 1 where presently exposed tailings or pond bottom sediments are capped and revegetated.

Time to Complete. Completion of all work necessary to implement this alternative can be accomplished over a two-year construction period.

5.1.6 Implementability

Ability to Construct and Operate. This alternative will be difficult to construct. The wetland conditions which exist in the area below Pond 1 and in the eastern third of Pond 1 will make it difficult to construct the drain in Pond 1 and to completely remove the tailings and associated soils from below Pond 1. Extensive dewatering will be required, as well as the installation of protective structures to reduce the potential for offsite migration of contamination during the construction process. In addition, low ground-pressure equipment, "swamp pads" or other measures will need to be used in saturated and/or weak soil areas.

The potential also exists for extending the boundaries of the existing contaminated material into presently uncontaminated areas. As discussed in Section 3.3.2 above, this potential

is especially high in the area below Pond 1 during the removal process. Should this occur, additional material would need to be removed until the removal protocol requirements were achieved.

Operation of the system, once constructed, will be simple and straight forward. The only mechanical equipment incorporated into this alternative are the motors and pumps associated with the ground-water interception and pumping system. "Operation" of the dry-closed areas will consist of inspecting the area for settlement and erosion, and repairing any damage which may occur. This is expected to require minimal effort.

Reliability. The proposed alternative will have a high degree of reliability with respect to accomplishing the objectives of the proposed remediation. Removal of all tailings and associated soils from below Pond 1 will eliminate any potential for human or environmental exposure within that particular area and will also eliminate any contact between these materials and the underlying ground water. Dry closure of Pond 1 will be effective in preventing human and environmental exposure. The dry closure cap will require only limited maintenance and can be considered to be very reliable relative to the purpose for which it intended.

The ground-water interception and pumpback system is the only component of this plan which involves the use of mechanical equipment. Regular inspection and maintenance of this equipment would effectively minimize the potential for offsite release of contaminated water. Ground-water flows which ultimately discharge to surface water in the Mill-Willow Bypass have been estimated in the ROD[14] to be very minor (approximately 1 cfs). Consequently, even with complete failure of the ground-water interception system, no measurable impact to surface- or ground-water quality is anticipated, especially given the short time which would be required to repair any conceivable failure in comparison to the low velocity of ground-water flow.

Ground water beneath Pond 1 will continue to be affected to some degree by contaminants leaching from the overlying tailings for an indeterminate period of time. The tailings will continue to drain interstitial (pore) water and the potential for direct and/or capillary zone contact between the tailings and underlying ground water will persist. This situation may require that the ground-water interception system located downstream of the Pond continue to be operated for an indefinite period of time. However, the ground-water interception system is expected to be highly reliable with respect to its ability to intercept any contaminated ground water before it can leave the site. Overall, the system should be highly reliable and stable, and very little risk is anticipated with its continued effective operation.

Ability To Monitor Effectiveness Of Remedy. Monitoring of the effectiveness of this alternative will be reliable and effective. Ground-water monitoring wells will be installed a short distance up- and downgradient of the ground-water interception trench located at the toe of the Pond 1 dike. The primary purpose of these wells is to establish that the interception trench has created an effective hydraulic barrier to prevent ground-water flow to the north. It is expected that samples from these wells will show some contamination until the aquifer is sufficiently flushed of existing metals contaminants. So long as non-compliance with ground-water ARARs

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[14] ROD, Part II, Section 4.3.3, p.2-17.

continues, pumping of the interception trench will be continued. Water from the interception trench will be pumped to Pond 3 for treatment.

If sampling of the wells demonstrates consistent compliance with MCLs, and samples taken from the interception trench indicate that surface-water quality ARARs are met, pumping of the interception trench could be discontinued. Once pumping is discontinued, a surface discharge channel (gravity drain) to Silver Bow Creek would have to be constructed from the trench at the toe of Pond 1 to maintain the lowered ground-water table beneath Pond 1. Sampling of the interception trench and wells would be continued to verify compliance with ARARs. The pumpback system would be maintained so that pumping could be reinstituted if indicated by subsequent monitoring results. See Section 7.2 for more detailed discussion of the proposed ground-water monitoring system.

Monitoring of the effectiveness of the dry closure can be easily accomplished by visually inspecting the condition of the cover on a periodic basis. Areas which settle or are otherwise altered from the final closure configuration can be easily repaired as required to ensure continued effectiveness.

Availability Of Equipment And Services. This alternative does not require the use of specialized equipment or services on an operational basis. The only significant equipment used on a continuing basis are the pumps and motors associated with the ground-water interception system. This equipment is standard "off-the-shelf" equipment which can be readily obtained.

Equipment and services necessary to construct the improvements and relocate or cover the tailings and associated soils are readily available in the area. Most work required is typical of construction normally undertaken by contractors working in the region. Should dredging be the selected method of removal for the area below Pond 1, equipment and experienced personnel would have to be secured from geographic areas where this type of construction is normally undertaken.

Workers in the area will need 40-hour health and safety training. Several schools exist in the immediate area which are capable of providing the necessary training. Availability of equipment and services will not be an impediment to implementation and continued operation of this alternative.

Availability of Technologies. The technology necessary for the implementation and operation of this alternative is readily available. No new or unproven technology is required.

5.1.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 1 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 1		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$30,997,008	$25,000	$31,381,321

5.2 Alternative No. 2 (Dry Close Pond 1, Wet Close Below Pond 1)

5.2.1 Overall Protection Of Human Health And The Environment

This alternative provides the same level of protection relative to Pond 1 as Alternative No. 1. This is because the same solution is proposed (dry closure) as in Alternative No. 1. Refer to the evaluation of Alternative No. 1 in Section 5.1.1 for a detailed analysis.

Wet closure below Pond 1 will effectively minimize the potential for significant human or terrestrial environmental exposure to contaminated material within this area. All tailings will be inundated with water, thereby reducing the potential for contact over any extended period of time. Human contact would be possible if workers or sportsmen were to enter the Ponds without protective clothing such as boots or waders. However, this is a highly unlikely situation and would not result in any significant hazard. Waterfowl and terrestrial wildlife could come into contact with the tailings. However, exposure would be very limited in time and would not represent a significant hazard. The potential for airborne migration of contaminants is effectively eliminated by wet closure.

5.2.2 Compliance With ARARs

This alternative contains many of the same components as Alternative No. 1, except that tailings and associated soils below Pond 1 would be left in place rather than be removed. Consequently, little difference exists with respect to ARARs compliance as relates to the corrective actions within Pond 1.

Wet closure of the area below Pond 1 will meet all ARARs. No ARARs directly apply to tailings and associated soils. These materials will be remediated in accordance with the proposed protocol described in Section 7.3. Ground-water ARARs will be met by construction of a ground-water interception trench downgradient of the tailings and associated soils which will ensure that no contaminated ground water will leave the site. The area below Pond 1 will be protected from flooding by extending a dike north from the northwest corner of the Pond 1 dike which will extend to the east hills on the east side of the lower Silver Bow Creek channel. This will insure that flows up to the 0.5 PMF in the Mill-Willow Bypass or Warm Springs Creek will not flood or erode this area. Runoff originating in the east hills will be intercepted in a channel constructed along the east side of the site, diverted around the wet-closure area and discharged downstream in Silver Bow Creek.

5.2.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Residual risks relative to Pond 1 are the same as those identified for Alternative No. 1. Risks remaining for the area below Pond 1 include the potential for flooding of the area if a 0.5 PMF flow is exceeded. This could result in downstream transport of some of the tailings and associated soils. This is considered an extremely small and acceptable risk given the very long return period for such an event. Furthermore, 0.5 PMF flood protection is the same level of protection required in the ROD for the much greater volumes of pond bottom sediments, tailings and associated soils within the Operable Unit upstream of Pond 1.

Risks associated with the potential for human, terrestrial wildlife and waterfowl contact are acceptably reduced by covering all tailings and associated soils below Pond 1 with water. Any contact would be for a very limited time period and would not be expected to have any detrimental effects.

Ground water beneath Pond 1 will continue to be affected by contaminants leaching from the overlying tailings for an indeterminate period of time as described in Section 5.1.3 under Alternative No. 1. This may result in continuing local exceedance of MCLs, thereby requiring operation of the interception/pumpback system at the downstream toe of Pond 1 for an indefinite period of time. Similarly, the downstream interception trench and pumpback system will be operated as long as required to intercept and treat ground water exceeding MCLs from the area below Pond 1. Although the duration of pumping is unknown, the proposed source controls in wet closures are intended to improve ground-water quality over time and eventually achieve consistent compliance with MCLs.

Adequacy of Controls. Operational controls would be required to control pumping of the ground-water interception trench. Also, control of the rate of flow through the wet-closure area would be required. Since wet closure of the area below Pond 1 would result in a situation conducive to recreational use, access controls would be required to insure that use by the public would not interfere with the operational objectives of the system. Institutional controls are necessary to ensure that no wells are installed above the downstream ground-water interception trench unless or until monitoring results verify consistent compliance with ARARs.

5.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. No treatment process is used directly in remediation of Pond 1. Treatment of intercepted ground water below Pond 1 will be accomplished by pumping the intercepted water to Pond 3.

The tailings and associated soils located below Pond 1 will be treated using source controls which will include the application of lime before flooding and by circulating high pH water through the wet-closure cells. These remedial measures will be supplemented by the natural biologic activity which will develop in the wet closures. The specific chemical forms, quantities and application/mixing method of lime to be applied before flooding would be evaluated during Remedial Design. High pH water from Pond 2 would be used to flood and

maintain circulation through the wet-closed areas. The flow-rate through the wet closure and the need for supplemental pH control will be evaluated during Remedial Design. Wet closure will create a small downward gradient to the shallow aquifer. The proposed chemical fixation will immobilize most of the soluble metals in the tailings and associated soils over time, thereby decreasing the transport of metals to the aquifer. Although not quantifiable, the flushing of high pH, lime-enriched wet-closure water through the tailings and into the shallow aquifer should also act to precipitate and immobilize some of the existing dissolved metals in the ground water.

Amount of Material Treated or Destroyed. No contaminated material in Pond 1 would be treated or destroyed. Tailings in the area below Pond 1 would be treated with lime and high pH water which will immobilize the soluble metals over time. This in-situ treatment will reduce the potential availability of metals in the environment by fixing the metals in a less-soluble state. This will significantly reduce the migration of metals to the underlying ground water.

Degree of Expected Reductions In Toxicity, Mobility, and Volume. Alternative No. 2 will contain the contaminated media within the Operable Unit boundaries. Solid contaminated media will be isolated and managed onsite through flood protection, capping with soil and/or water, dike stabilization, and ground-water interception and treatment and/or in-situ treatment of dissolved or soluble metals. The in-situ treatment should reduce the availability of metals in the environment by fixing contaminants in a less-soluble state. However, it is generally assumed that toxicity, volume, persistence and propensity to bioaccumulate related to the long-term management of pond bottom sediments and tailings and associated soils on-site will not be significantly changed. The toxicity of a very small volume of metals in ground water treated in Pond 3 will be reduced, but the reduction is insignificant in view of the total volume of metals present within the Operable Unit. No reduction in volume of contaminated materials is effected by this alternative.

Degree to Which Treatment is Irreversible. Treatment of intercepted ground water in Pond 3 as proposed in this alternative is an irreversible process given the controls on treatment within the Ponds system. Similarly, treatment of metals in the tailings and associated soils or ground water underlying the wet-closure area is reversible only if pH is lowered, thereby increasing the potential mobility of the metals. Operational controls and maintenance would be instituted to maintain pH in the wet-closure cells at the appropriate levels.

Type and Quantity of Residuals Remaining. Treatment of tailings and ground water will result in residual insoluble metals precipitates in the wet closure and Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.2.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. Risks to the surrounding community during the remedial action will be insignificant. Construction of the dry-closure cover presents a potential for generation of dust, and construction traffic will increase. However, controls would be implemented during construction to minimize dust and control

traffic. Construction of the wet-closure dikes poses no special risks to the surrounding community.

Protection of Workers During Remedial Actions. Exposure of workers to contaminated materials during the remediation process is possible. These risks would be reduced to acceptable levels through the use of appropriate protective clothing and equipment, as well as by the implementation of management and worker training programs.

Environmental Impacts. Environmental impacts will be significant in Pond 1. Dry closure of Pond 1 will eliminate all existing wetlands. The wetlands will be replaced with natural soils supporting dry grassland vegetation. Due to the nature of this proposed remedy, it will not be possible to reestablish the destroyed wetlands within Pond 1. A positive impact will result in the western portion of Pond 1 by establishing grasslands in presently unvegetated areas of exposed tailings.

Environmental impacts in the area below Pond 1 will be positive. Covering all existing exposed tailings with water will improve waterfowl and terrestrial habitat in the immediate area, and expand the area and enhance the character of the existing wetland. The proposed wet-closure ponds will be relatively shallow which will allow for significant growth of aquatic vegetation within the ponds and along the perimeter. This will provide additional desirable cover and nesting habitat for birds and waterfowl.

Time to Complete Remedial Actions. Completion of all work associated with the implementation of Alternative No. 2 can be accomplished in a two-year construction period.

5.2.6 Implementability

Ability to Construct and Operate. Construction and operation of the system contemplated by this alternative pose no special problems. No special difficulties are anticipated except those identified in Alternative No. 1 which relate to the dry closure of Pond 1. Construction of the wet-closure dikes in the area below Pond 1 would be performed when the ground was frozen, or would utilize standard ground-improvement techniques and/or materials.

Operation of the system will be simple and straight forward. The ground-water interception system can be designed to operate automatically with routine inspection and maintenance. Operation of the dry-closed area will involve little more than monitoring the integrity of the cover and making minor repairs if settlements occur which expose contaminated material or allow runoff to pond on the cover.

Reliability. The proposed remediation under Alternative No. 2 will be highly reliable with respect to accomplishing the objectives of the proposed remediation. Dry closure of Pond 1 will be effective in preventing human and environmental contact. The dry closure cap will require only limited maintenance and can be considered to be very reliable relative to the purpose for which it is intended. Similarly, the wet closure below Pond 1 will effectively minimize human and terrestrial wildlife and waterfowl contact. Minor maintenance of the dikes and overflow weirs may be required periodically to ensure the otherwise essentially automatic flow-through operation of the wet-closure system.

The ground-water interception and pumpback system is the only component of this plan which involves the use of mechanical equipment. Regular inspection and maintenance of this equipment would effectively minimize the potential for offsite release of contaminated water. Ground-water flows which ultimately discharge to surface water in the Mill-Willow Bypass have been estimated in the ROD[15] to be very minor (approximately 1 cfs). Consequently, even with complete failure of the ground-water recovery system, no measurable impact to surface- or ground-water quality is anticipated, especially given the short time which would be required to repair any conceivable failure in comparison to the low velocity of ground-water flow. The combined ground-water interception system under Alternative No. 2 is expected to be highly reliable with respect to its ability to intercept any contaminated ground water before it can leave the site. Overall, the system should be very reliable and stable, and very little risk is anticipated with its continued effective operation.

Ability to Monitor Effectiveness of Remedy. The monitoring system planned for this alternative will provide all information necessary to conclusively establish the effectiveness of the remedy. The ground-water monitoring wells located both up and downgradient of the ground-water interception trenches will provide the information necessary to demonstrate that no contaminated ground water is leaving the site. These wells will be used as sampling points and for obtaining measurements of the ground-water levels to establish that the interception trench is functioning properly as a hydraulic barrier. The proposed monitoring system is further described in Section 7.2.

Availability of Equipment and Services. The discussion in Section 5.1.6 of this issue for Alternative No. 1 applies to this alternative also. No significant issues or problems in regard to equipment and services are anticipated.

Availability of Technologies. The technologies necessary for the implementation and operation of this alternative are readily available. No new or unproven technology is required.

5.2.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 2 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 2		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$25,092,680	$50,000	$25,861,305

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[15] ROD, Part II, Section 4.3.3, p.2-17.

5.3 Alternative No. 3 (Dry Close Pond 1, Dry Close Below Pond 1)

5.3.1 Overall Protection of Human Health and the Environment

For a complete discussion of this topic with respect to the dry closure of Pond 1, refer to Section 5.1.1 of the evaluation of Alternative No. 1. Dry closure of the area below Pond 1 does not directly affect the analysis of the dry closure of Pond 1 which has been evaluated previously.

Dry closure of the area below Pond 1 will provide overall protection of human health and the environment. The dry-closure cover will effectively prevent contact with the tailings and associated soils. The cover will also prevent airborne migration of tailings. The flood protection channel on the east side of the area will prevent erosion from flooding originating in the hills east of the site. The extended north-south dike along the Mill-Willow Bypass will provide protection from flooding due to high flows in the Bypass or Warm Springs Creek. These facilities will protect surface water in the area from contamination caused by erosion of tailings and associated soils which would otherwise be transported to Silver Bow Creek and the Clark Fork River during large flood events.

Ground water below Pond 1 will be remediated by construction of the ground-water interception and pumpback system downstream of the dry-closed area. Contamination originating from the tailings located in Pond 1 or the area below Pond 1 which might enter the underlying aquifer will be intercepted before leaving the site and returned to Pond 3 for treatment.

5.3.2 Compliance With ARARs

This alternative complies with all ARARs for the four media of concern. Refer to the discussion of ARARs in Sections 5.1.2 and 5.2.2 for Alternatives No. 1 and No. 2, respectively for additional information.

5.3.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Residual risks remaining after the completion of the implementation of this alternative are minimal. The tailings and associated soils and pond bottom sediments within and below Pond 1 are protected from flooding up to the 0.5 PMF event. This will effectively minimize the potential for surface-water contamination due to erosion caused by flooding. Protection from human or environmental contact is provided by the dry-closure cap.

Offsite ground water is protected by the interception and treatment of any contaminants which are present in or might enter the underlying shallow aquifer. However, the potential mechanisms for long-term, limited flux of metals to the shallow ground-water aquifer are essentially the same as described in Section 5.1.3 for Alternative No. 1. Under this alternative, the magnitude of metals loading would likely be greater due to the much larger area of dry closure.

Adequacy of Controls. Few controls are required to operate the system to achieve consistent compliance with ARARs. The only mechanical equipment proposed is the pumping equipment necessary to return any contaminated ground water to Pond 3 for treatment prior to release to the Bypass. Access or other institutional controls are only necessary to ensure that no wells are installed above the ground-water interception trench until or unless monitoring results verify consistent compliance with ARARs.

5.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. This alternative does not utilize a treatment process other than the ground-water interception and subsequent treatment in Pond 3. Pond bottom sediments and tailings and associated soils are not treated but are covered to prevent erosion and direct contact.

Amount of Material Treated or Destroyed. None of the tailings and associated soils or pond bottom sediments are treated or destroyed. Only contaminated ground-water will be treated.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. No significant reduction in toxicity or volume will occur as a result of the implementation of this alternative. The toxicity of a very small volume of metals in ground water treated in Pond 3 will be reduced, but the reduction is insignificant in view of the total volume of metals present within the Operable Unit. The potential for mobility of the contaminated material is reduced to acceptable levels by providing protection from flooding and earthquakes, wind erosion, and by the interception of any ground water which may be contaminated.

Degree to Which Treatment is Irreversible. Treatment, other than the treatment of intercepted ground water, is not proposed in this alternative. Ground-water treatment is effectively irreversible as discussed in Section 5.1.4 under Alternative No. 1.

Type and Quantity of Residuals Remaining. Treatment of intercepted ground water will result in residual insoluble metals precipitates in Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.3.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. No significant risks to the community are anticipated under implementation of Alternative No. 3. Dust and runoff controls will be instituted during the construction process and will be effective in minimizing the potential for releases of contaminated materials. Appropriate controls will be implemented to minimize the risks or impacts of increased construction traffic.

Protection of Workers During Remedial Actions. Exposure of workers to contaminated materials during the remediation process is possible. Risks associated with such potential exposures can be reduced to acceptable levels through the use of appropriate protective

clothing and equipment, as well as by the implementation of management and worker training programs.

Environmental Impacts. Environmental impacts associated with the dry closure of Pond 1 would be significant. Draining of the wetlands which presently exist in the eastern one-third of the Pond would result in the complete destruction of very desirable waterfowl habitat. This would be an irreversible loss. Wetlands which also presently exist below Pond 1 would also be permanently destroyed. Since this alternative contemplates dry closure of this area, it would not be possible to restore this area to its original condition after completion of the construction of the dry-closure cap. A gravity drain from the toe of the Pond 1 dike to the downgradient ground-water interception trench would be necessary to maintain a lowered ground-water table in Pond 1 if pumping of the Pond 1 trenches was discontinued. This drain would preclude significant wetlands development below Pond 1. All existing vegetation in both areas would also be destroyed during the construction of this alternative. Reclamation of the remediated areas would result in dry grassland habitat in place of the existing wetlands.

Time to Complete Remedial Actions. Two years will be required to complete the construction of Alternative No. 3.

5.3.6 Implementability

Ability to Construct and Operate. For a discussion relating to the construction and operation of the dry closure of Pond 1, refer to Section 5.1.6 under the evaluation of Alternative No. 1. No significant differences exist between Alternative No. 3 and Alternative No. 1 relative to dry closure of Pond 1. Dry closure of the area below Pond 1 will be fairly difficult. The area will need to be rough graded and drained before installation of the dry closure cap. Dewatering will be equipment intensive and time consuming but should be effective in minimizing standing water above the tailings and associated soils prior to capping. It is not necessary, nor is it practical, to fully dewater the tailings and underlying natural soils during construction. Operation of the system will be relatively simple, primarily involving the operation of the ground-water return pumps.

Reliability. This alternative will have a high degree of reliability with regard to accomplishing the objectives of the remediation. The only mechanical equipment requiring regular operation and maintenance is that associated with the ground-water interception and treatment system. Ground-water flows which ultimately discharge to surface water in the Mill-Willow Bypass have been estimated in the ROD[16] to be very minor (approximately 1 cfs). Consequently, even with complete failure of the ground-water interception system, no measurable impact to surface- or ground-water quality is anticipated, especially given the short time which would be required to repair any conceivable failure in comparison to the low velocity of ground-water flow. The dry-closure caps on both Pond 1 and the area below would not be subject to any condition which would cause rapid failure. Routine inspection and maintenance will ensure a high degree of reliability relative to their ability to meet the objectives of the remedy.

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[16] ROD, Part II, Section 4.3.3, p.2-17.

Ability to Monitor Effectiveness of Remedy. The monitoring system for Alternative No. 3 is identical to that proposed for Alternative No. 2. The system will have the capability to establish the effectiveness of the ground-water hydraulic barrier, and monitor the quality of ground water up- and downgradient, as well as in the interception trenches. Taken together, the hydraulic and water quality data will fully monitor the effectiveness of the remedy in meeting ground-water ARARs. Additional discussion of the proposed monitoring system is provided in Section 7.2.

Availability of Equipment and Services. The discussion in Section 5.1.6 of this issue for Alternative No. 1 applies to this alternative also. The equipment and services required to construct and operate this alternative are immediately available within the area. No unique problems associated with equipment or services are foreseen should this alternative be chosen.

Availability Of Technologies. The technology necessary for the implementation and operation of this alternative is readily available. No new or unproven technology is required.

5.3.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 3 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 3		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$25,762,212	$35,000	$26,300,250

5.4 Alternative No. 4 (Wet/Dry Close Pond 1, Remove Tailings Below Pond 1)

5.4.1 Overall Protection of Human Health and the Environment

The western two-thirds of Pond 1 will be covered with an earthen cap which will prevent human and environmental contact with the tailings and associated soils and pond bottom sediments. This earthen cover will also prevent airborne release of contaminants. The eastern one-third of Pond 1 will be wet closed by permanently inundating all exposed tailings and pond bottom sediments. Wet closure will also provide an appropriate barrier to contact and prevent wind erosion. The entire Pond area will also be protected from flood events up to the 0.5 PMF and earthquakes up to the MCE. This will prevent offsite release and potential surface-water degradation due to downstream transport of eroded tailings. Ground water will be intercepted by constructing a trench along the full length of the downstream toe of the Pond 1 dike. The intercepted ground water will be pumped to Pond 3 for treatment for as long as necessary to achieve compliance with ARARs. This interception and treatment system will prevent offsite migration of potentially contaminated ground water.

Removal of all tailings and associated soils from below Pond 1 will provide complete protection of human health and the environment from exposure to these materials within the remediated area. However, significant negative impacts to the environment will occur during the removal process as discussed in Section 5.4.5.

5.4.2 Compliance With ARARs

This alternative will comply with all ARARs for the media of concern. All of Pond 1 will be designed against failure caused by earthquakes up to the MCE. This will include lowering and regrading the east-west Pond 1 dike to enhance stability. Flood protection will be provided up to the 0.5 PMF.

Ground-water ARARs will be met by intercepting the full-depth of the shallow aquifer at the toe of Pond 1 and pumping the intercepted flow back to Pond 3 for treatment. No surface water will be impacted following implementation of this alternative. Runoff from direct precipitation on the dry-closed portion of Pond 1 will be directed by surface grading of the cap to the northwest corner of the Pond. Collected runoff will flow through a small flap-gated culvert or an equivalent structure to the area below Pond 1. Direct precipitation on the wet-closure area will be accommodated in temporary storage. The collected water will evaporate and/or be metered to the interception trench and pumped back to Pond 3. Since the area below Pond 1 will no longer contain any contaminated material, surface water runoff from this area will not have any negative impacts on receiving streams. Offsite surface water will not be impacted by ground water since all contaminated ground water will be intercepted before it reaches and discharges to the Mill-Willow Bypass, Silver Bow Creek or the Clark Fork River.

5.4.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Residual risks remaining after implementation of Alternative No. 4 are minimal. Removal of all tailings and contaminated soils below Pond 1 will eliminate any future risks in this area. Residual risks mainly involve the potential for failure of the Pond 1 dry-closure cover due to excessive differential settlement and/or failure of the Pond 1 dikes due to natural events which exceed the design criteria. The risk of dry-closure cover failure is effectively minimized by periodic inspection and maintenance. The probability or risk of floods or earthquakes occurring which exceed the design bases of the Pond 1 dikes is extremely low.

The potential for offsite release of contaminated ground water is minimized by the interception trench and pumpback system. There is some potential for long-term, limited flux of metals from the tailings in Pond 1 into the shallow aquifer under implementation of the wet and dry closures for this alternative. Although source controls in the wet closure are intended to chemically fix metals contaminants, this treatment may not be completely effective, especially in the short term. Also, some hydraulic contact may continue to exist between tailings in the dry closure area and the underlying ground water. Depending on actual site conditions under the proposed remediation, these mechanisms could lead to continuing local MCL exceedances and require pumpback of the intercepted ground water over the long term.

Adequacy of Controls. Few controls are required by this alternative, either physical or institutional. Physical (i.e., operation and maintenance) controls will be required to manage the ground-water interception and treatment and wet-closure systems. Institutional controls might include access control, restrictions on allowable future uses of the area, and prohibition of wells unless or until monitoring data verify consistent compliance with ARARs. None of these potential controls should significantly impact the ability to effectively implement the remedy and operate the facilities proposed in this alternative.

5.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. Treatment of intercepted contaminated ground water in Pond 3, application of lime to tailings and associated soils prior to wet closure and circulation of high pH water through the wet closure cells in Pond 1 are proposed in Alternative No. 4. In addition to the liming and pH maintenance, natural biologic activity in the wet-closure cells would provide some additional degree of metals removal. Additional discussion pertinent to the chemical fixation in the wet closure is provided in Section 5.2.4 under Alternative No. 2.

Amount of Material Treated or Destroyed. Tailings and pond bottom sediments within the wet-closed portion of Pond 1 would be treated with lime and high pH water which will immobilize the dissolved and soluble metals over time. This in-situ treatment will reduce the potential availability of metals in the environment by fixing the metals in a less-soluble state. This will significantly reduce or prevent the migration of metals from this source to the underlying ground water.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. Implementation of Alternative No. 4 will not result in any reduction in volume of contaminated media. A reduction in the total surface area of tailings and associated soils will occur as a result of removing material from below Pond 1 and placing it in Pond 1. However, the total volume of material will remain the same.

The potential for offsite release of the tailings and associated soils and pond bottom sediments will be significantly reduced to acceptable levels. Protection from flooding and wind erosion will be provided. The potential for failures caused by earthquakes will also be minimized. Migration of contaminated ground water off site will be prevented by the interception trench. Metals in contaminated ground water pumped to Pond 3 will be immobilized by precipitation in the upgraded WSP treatment system. The mobility of metals in tailings and sediments inundated in the wet-closure cells will likewise be substantially reduced by forming insoluble precipitates through the chemical fixation processes described above.

Toxicity of the contaminated media will remain unchanged, except for soluble or dissolved metals which are precipitated through chemical fixation in the wet closure or Pond 3. Protection from the various contaminated media is provided by the construction of physical barriers consisting of either water inundation or earthen cover.

Degree to Which Treatment is Irreversible. Treatment of intercepted ground water in Pond 3 as proposed in this alternative is an irreversible process given the controls on

treatment within the Ponds system. Similarly, treatment of metals in the tailings and associated soils or ground water underlying the wet-closure area is reversible only if pH is lowered, thereby increasing the potential mobility of the metals. Operational controls and maintenance would be instituted to maintain pH in the wet-closure cells at the appropriate levels.

Type and Quantity of Residuals Remaining. Treatment of pond bottom sediments, tailings and ground water will result in residual insoluble metals precipitates in the Pond 1 wet closure and in Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.4.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. Prior discussion of this item for each of the other alternatives evaluated also applies to Alternative No. 4. No special problems are associated with this alternative.

Protection of Workers During Remedial Actions. For a discussion of this issue as it relates to complete removal below Pond 1, see Section 5.1.6 under Alternative No. 1. Wet and dry closure of Pond 1 is not expected to cause any special problems relative to protection of workers during the remedial action. Worker training and implementation of appropriate safeguards will be required of contractors implementing this alternative.

Environmental Impacts. Complete removal below Pond 1 will result in the irreversible destruction of the existing wetlands. This is a serious negative environmental impact given the national priority of no net loss of wetlands. Removal of all tailings and associated soils will require excavation of essentially all of the existing relatively impermeable natural soils down to the sand and gravel aquifer. It will not be possible to reconstruct the wetlands after the removal process is completed due to the high permeability of the aquifer and the interception of ground water upgradient at the toe of the Pond 1 dike.

Wet and dry closure of Pond 1 will preserve the wetlands which presently exist in the eastern one-third of the Pond. Construction of wet-closure ponds will effectively increase the total area of inundation, thereby resulting in an increase in the wetland area and enhancement of the character of the wetlands. Dry closure of the western two-thirds of Pond 1 will increase the total area of grassland vegetation by capping and seeding the existing areas of exposed, unvegetated tailings.

Time to Complete Remedial Actions. The remedial actions proposed by Alternative No. 4 can be constructed in a two-year period.

5.4.6 Implementability

Ability to Construct and Operate. For a discussion of this subject as it relates to complete removal below Pond 1, see section 5.1.6 under Alternative No. 1. Wet and dry closure of Pond 1 does not involve any special problems relative to construction and operation. Appropriate operation and maintenance will be required to control flow through the wet-closure

area. In addition, regular inspection and maintenance of the ground-water interception and pumping system will be required to insure its continued effective operation.

Reliability. The remedial plan proposed as Alternative No. 4 would be very reliable. Removal of all material below Pond 1 will effectively eliminate any potential for problems associated with this area. The discussion in Section 5.2.6 under Alternative No. 2 regarding reliability is applicable to the wet and dry closure of Pond 1 in this alternative. The proposed closures will be fully effective and reliable in minimizing or eliminating contact with tailings and associated soils or pond bottom sediments. Any contamination of the ground water underlying Pond 1 will be remediated by interception and treatment. Inspection and regular maintenance of the pumping equipment will achieve high reliability. However, as discussed in Section 5.1.6 under Alternative No. 1, even complete failure of the pumpback system would not result in any significant impact to surface or ground water offsite during the short time required to repair any conceivable failure.

Ability to Monitor Effectiveness of Remedy. Monitoring of the effectiveness of the system is simple and straightforward. Monitoring wells located immediately up- and downgradient of the ground-water interception trench will provide the water level information to establish that an effective hydraulic barrier exists (i.e., that no ground water is flowing north from Pond 1). These wells will also be sampled for ground-water quality to monitor compliance with MCLs. The discussion in Section 5.1.6 under Alternative No. 1 relative to sampling of the intercepted water and potential discontinuation of pumping is generally applicable to this alternative. However, since lowering of the water table beneath Pond 1 is not proposed in this alternative, a surface discharge channel to Silver Bow Creek would not be required. Additional discussion of the proposed ground-water monitoring system is provided in Section 7.2.

Availability of Equipment and Services. Equipment and services required to construct and implement this alternative are readily available. See Section 5.1.6 for additional discussion on this topic in regard to the removal below Pond 1.

Availability of Technologies. Technologies utilized to implement the work proposed by this alternative are available and proven.

5.4.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 4 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 4		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$23,181,839	$45,000	$23,873,602

5.5 Alternative No. 5 (Wet/Dry Close Pond 1, Wet Close Below Pond 1)

5.5.1 Overall Protection of Human Health and the Environment

Protection of human health and the environment is provided by physical barriers (water and/or earthen cover) which minimize to acceptable levels or preclude direct contact, and prevent airborne dispersal of the contaminated material. The contaminated material is protected from flooding and erosion from runoff by construction of flood dikes and runoff interceptor channels. These measures also protect offsite surface waters from contamination by onsite runoff or eroded tailings and associated soils or pond bottom sediments. Ground water is remediated by construction and operation of facilities designed to intercept and treat any onsite ground water which exceeds MCLs. This alternative is similar in concept to all other alternatives in this respect.

5.5.2 Compliance With ARARs

Alternative No. 5 will comply with all ARARs for the four media of concern. For a complete discussion of ARARs compliance, refer to Sections 5.2.2 and 5.4.2 under Alternatives No. 2 and No. 4, respectively. Alternative No. 2 includes wet/dry closure of Pond 1 and Alternative No. 4 includes wet closure below Pond 1. The combination proposed by this alternative does not affect the ability of the individual remedies of each of the areas of concern to meet the ARARs requirements.

5.5.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. The residual risks remaining under implementation of Alternative No. 5 relate primarily to the probability of natural flood or earthquake events occurring which exceed the design criteria. The probability of a flood event exceeding the 0.5 PMF or an earthquake exceeding the MCE is extremely remote, and the associated residual risks are acceptable. This is consistent with the design criteria and residual risks applicable to the remainder of the WSP Operable Unit, which contains much greater volumes of contaminated media than the area within and below Pond 1.

As discussed in Sections 5.2.3 and 5.4.3, source controls would be implemented as part of the wet closures proposed within and below Pond 1. These controls are intended to minimize the potential for continued leaching of metals from tailings or pond bottom sediments to the underlying shallow aquifer. However, there is some potential that such loadings, although limited, may occur and could result in local (onsite) exceedances of MCLs for an indeterminate period of time. The proposed downgradient interception and pumpback system effectively eliminates any residual risk that offsite surface or ground water will be impacted by any such MCL exceedances.

Adequacy of Controls. Similar controls will be required for this alternative as for all other alternatives proposed. Operational and maintenance control of flow through the wet-closure areas and of the ground-water interception and treatment system will be required. These physical controls are relatively simple and will ensure effective performance of the system. Institutional and access controls will be required to regulate recreational uses and provide

wildlife and waterfowl management. This will be especially important as a result of the significant wetland habitat enhancements derived by implementation of this alternative. Institutional controls to prohibit wells onsite will also be required until or unless ground-water monitoring demonstrates consistent compliance with ARARs.

5.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. Treatment in this alternative will consist of interception of contaminated ground water and subsequent treatment in Pond 3, as well as source-control treatment of existing tailings located below the wet-closed areas through the application of lime prior to submerging the tailings with high pH water. These treatment or chemical fixation measures will result in significant reduction of metals mobility and toxicity by forming insoluble precipitates. See Sections 5.2.4 and 5.4.4 for additional discussion of this issue.

Amount of Material Treated or Destroyed. All ground water which would otherwise flow offsite will be intercepted and treated in Pond 3 as long as necessary to meet ARARs. Tailings and pond bottom sediments located below the wet-closure areas will be treated with lime and high pH water to reduce the potential mobility of the metals by fixing them in an insoluble state. Material located in the dry-closed area of Pond 1 will not be treated. None of the contaminated material will be destroyed.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. Toxicity of the contaminated media will remain unchanged, except for those soluble or dissolved metals which are precipitated through chemical fixation in the wet closures or Pond 3. The potential for mobility (i.e., offsite release) of tailings and associated soils and pond bottom sediments offsite will be effectively eliminated by physical measures to protect against flooding and earthquakes. The potential for migration of metals to the ground water beneath the wet-closed areas will be reduced by the previously described source-control measures. Any ground water onsite which exceeds MCLs will be intercepted and treated. Tailings and pond bottom sediments which are dry closed will not be treated. Consequently, some potential remains for limited transport of metals to the underlying ground water. Ground water beneath the site which is contaminated from this source will be intercepted and treated until monitoring demonstrates consistent compliance with MCLs.

Degree to Which Treatment is Irreversible. Treatment of intercepted ground water in Pond 3 as proposed in this alternative is an irreversible process given the controls on treatment within the Ponds system. Similarly, treatment of metals in the tailings and associated soils or ground water underlying the wet-closure area is reversible only if pH is lowered, thereby increasing the potential mobility of the metals. Operational controls and maintenance would be instituted to maintain pH in the wet-closure cells at the appropriate levels.

Type and Quantity of Residuals Remaining. Treatment of pond bottom sediments, tailings and ground water will result in residual insoluble metals precipitates in the wet closures and in Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.5.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. Implementation of Alternative No. 5 will not involve any actions which would pose significant risks to the surrounding community. Risks associated with increased construction activity and traffic within the area would be minimized by implementation of appropriate safety control measures.

Protection of Workers During Remedial Actions. No significant hazards associated with the contaminated media onsite are anticipated in the construction of this alternative. Potential hazards associated with earthwork construction will be present, but are manageable. Risks to workers will be minimized through the use of appropriate protective equipment and education/training programs, including the requirement that all workers have completed a 40-hour health and safety program.

Environmental Impacts. Negative environmental impacts will be minimal, and are greatly outweighed by positive impacts associated with this alternative. Existing wetlands will be enlarged and enhanced by the construction of the wet-closure areas within and below Pond 1. Some removal of vegetation will be required to construct the wet-closure dikes and some areas which are now covered with shallow water or aquatic vegetation will be inundated. However, the proposed series of wet-closure cells will result in a net gain of wetlands habitat over that which presently exists. Construction of the flood protection dike and east hills interceptor channel will result in minor loss of existing grassland habitat. This loss will be more than balanced by establishment of dry grassland habitat in presently unvegetated areas in the western portion of Pond 1. The existing Mill-Willow Bypass channel will be utilized for the ground-water interception trench. A replacement Bypass channel will be constructed, thereby mitigating loss of the current section of channel.

Time to Complete Remedial Actions. The expected time required to complete the implementation of this alternative is two years.

5.5.6 Implementability

Ability to Construct and Operate. Construction and operation of this alternative require relatively common materials, equipment and methods. Construction of the wet-closure dikes can probably best be accomplished in the winter months when the ground is frozen due to the relatively soft, saturated foundation conditions. However, this is not a critical consideration as they can also be constructed when the foundation is not frozen utilizing standard ground improvement techniques and/or materials. Operation of the system will require regular inspection and maintenance of the ground-water interception and treatment system, and control of flow through the wet-closure cells.

Reliability. The system implemented under Alternative No. 5 would result in a high degree of reliability relative to achieving the remedial objectives. The interception trench and pumpback system provide a high degree of assurance that no contaminated ground water would leave the site. The wet and dry closures constructed to minimize or prevent direct contact with tailings and associated soils or pond bottom sediments are not subject to rapid failure which would pose a significant threat to human health or the environment.

Any contaminated ground water which would otherwise flow offsite will be remediated by interception and treatment. Inspection and regular maintenance of the pumping equipment will achieve high reliability. However, as discussed in Section 5.1.6 under Alternative No. 1, even complete failure of the pumpback system would not result in any significant impact to surface or ground water offsite during the short time required to repair any conceivable failure.

Ability to Monitor Effectiveness of Remedy. The ground-water monitoring system for Alternative No. 5 is the same in concept to that proposed for the other alternatives. The system will have the capability to establish the effectiveness of the ground-water hydraulic barrier, and monitor the quality of ground water up- and downgradient of the barrier. Taken together, the hydraulic and water quality data will fully monitor the effectiveness of the remedy in meeting ground-water ARARs. Additional discussion of the proposed monitoring system is provided in Section 7.2.

Availability of Equipment and Services. Equipment and services necessary to construct and operate this alternative are readily available in the area.

Availability of Technologies. The technologies required to implement and operate Alternative No. 5 are readily available. No new or unproven technology is required.

5.5.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 5 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 5		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$16,578,211	$70,000	$17,654,286

5.6 Alternative No. 6 (Wet/Dry Close Pond 1, Dry Close Below Pond 1)

5.6.1 Overall Protection of Human Health and the Environment

Covering the exposed tailings and associated soils and pond bottom sediments within and below Pond 1 with a combination of wet and dry closures will effectively protect human health and the environment. Wet and dry closure will minimize or prevent direct contact with the tailings and associated soils and pond bottom sediments, and prevent airborne migration of contaminants due to wind erosion. Although human or environmental contact with tailings in the wet-closure areas is possible, the limited duration and nature of the exposure would not represent a significant hazard. The tailings and associated soils and pond bottom sediments will be protected from erosion and transport downstream during flooding from the Mill-Willow Bypass, Warm Springs Creek, and drainage from the east hills. Flood protection will consist

of dikes and interceptor channels designed to accommodate flows or runoff up to the 0.5 PMF. The existing Pond 1 dike will be lowered and stabilized to prevent failure during earthquake loadings. Construction of the ground-water interception trench downstream of the dry-closure area below Pond 1 will prevent contaminated ground water from migrating offsite.

5.6.2 Compliance With ARARs

Alternative No. 6 will meet all ARARs for the media of concern at the site. See Sections 5.3.2 and 5.4.2 for additional discussion of ARARs compliance below and within Pond 1, respectively.

5.6.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. The residual risks associated with implementing Alternative No. 6 are minimal. Dry closure of the western portion of Pond 1 and the area below Pond 1 will prevent direct human or environmental contact with tailings. Wet closure of the eastern third of Pond 1 will reduce the risks associated with direct contact to acceptable levels. The flood and earthquake design criteria reduce the risk of offsite release of tailings and associated soils and pond bottom sediments to acceptable levels comparable to those which apply to the remainder of the contaminated materials within the Operable Unit.

The ground-water interception trench and pumpback system will effectively eliminate the potential for contamination migrating offsite. However, the potential for onsite long-term, limited flux of metals to the shallow aquifer exists for both the wet and dry closures proposed. This issue is discussed in more detail in Sections 5.1.3 and 5.2.3 under Alternative No. 1 and No. 2, respectively.

Adequacy of Controls. The only physical controls necessary as part of this alternative are the operation of the ground-water pumpback system, and control of flow through the Pond 1 wet-closure cells. Regular inspection and maintenance will be required to ensure that the wet and dry closures continue to function as intended. Institutional controls to prohibit wells within the remediated area will be required until or unless monitoring demonstrates consistent compliance with ground-water ARARs.

5.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Processes Used. Tailings and associated soils and pond bottom sediments within the dry closure in and below Pond 1 will not be treated. The earthen cover will provide protection against direct human and environmental contact. Ground water collected in the downgradient interception trench will be pumped to Pond 3 for treatment. In addition, the tailings and sediments within the Pond 1 wet closure will be treated with lime prior to flooding with high pH water from Pond 2. This wet-closure source control is described in more detail in Section 5.2.4 under Alternative No. 2.

Amount of Material Treated or Destroyed. Only the intercepted ground water and the tailings underlying the wet-closed portion of Pond 1 will be directly treated with implementation of Alternative No. 6. None of the contaminated media will be destroyed.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. Toxicity of the contaminated media will remain unchanged, except for those soluble or dissolved metals which are precipitated through chemical fixation of tailings in the wet closure in Pond 1 or intercepted ground water pumped to Pond 3. The potential for mobility (i.e., offsite release) of tailings and associated soils and pond bottom sediments offsite will be effectively eliminated by physical measures to protect against wind, flooding and earthquakes. The potential for migration of metals to the ground water beneath the wet-closed areas will be reduced by the previously described source-control measures. Tailings and pond bottom sediments which are dry closed will not be treated. Consequently, some potential remains for limited transport of metals to the underlying ground water. Ground water beneath the site which is contaminated from this or any other source will be intercepted and treated until monitoring demonstrates consistent compliance with MCLs.

Degree to Which Treatment is Irreversible. Treatment of intercepted ground water in Pond 3 as proposed in this alternative is an irreversible process given the controls on treatment within the Ponds system. Similarly, treatment of metals in the tailings and associated soils or ground water underlying the Pond 1 wet closure is reversible only if pH is lowered, thereby increasing the potential mobility of the metals. Operational controls and maintenance would be instituted to maintain pH in the wet-closure cells at the appropriate levels.

Type and Quantity of Residuals Remaining. Treatment of pond bottom sediments, tailings and ground water will result in residual insoluble metals precipitates in the Pond 1 wet closure and in Pond 3. However, the total volume of residuals is insignificant when compared to the total volume of pond bottom sediments and tailings and associated soils remaining onsite, and no measurable incremental risks are associated with these residuals.

5.6.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. Short-term risks to the surrounding community associated with this alternative are minimal. Dust from construction of the extensive dry closures would be controlled by watering, application of stabilizers or other appropriate methods. Increased construction activity and traffic would be controlled by implementing standard safety measures to minimize the associated offsite risks.

Protection of Workers During Remedial Actions. Exposure of workers to contaminated media during construction of Alternative No. 6 is possible. The risk associated with these potential exposures would be reduced to acceptable levels through the use of appropriate protective clothing and equipment, and by implementation of management and worker training programs. All remediation personnel would be required to have 40-hour health and safety training.

Environmental Impacts. Negative environmental impacts resulting from implementation of this alternative will be substantial. During construction, all wetlands, and other vegetation and wildlife habitat within the dry-closure area below Pond 1 will be destroyed. The existing wetland will be replaced by dry grassland habitat over most of the area. The environmental impact to the Pond 1 wet- and dry-closure areas will be positive. Wet closure of the east side of Pond 1 will expand and enhance the character of the wetland habitat which

already exists. Dry closure of the west side of Pond 1 will result in establishment of dry grassland habitat in presently unvegetated areas.

Time to Complete Remedial Actions. Completion of all work associated with the implementation of Alternative No. 6 can be accomplished in a two-year construction period.

5.6.6 Implementability

Ability to Construct and Operate. Construction of the proposed remediation under Alternative No. 6 is feasible and can be accomplished with standard equipment and methods. However, dry closure below Pond 1 will require rough grading and drainage of the tailings prior to cap construction. Dewatering will be equipment intensive and time consuming, but should be effective in removing standing water prior to capping. Operation of the system will require regular inspection and maintenance of the ground-water interception and treatment system, and control of flow through the wet-closure cells. Periodic inspection and maintenance of the dry-closure caps and wet-closure dikes and weirs will also be required.

Reliability. This alternative will provide highly reliable protection of human health and the environment. The dry closures effectively prevent direct contact with tailings and associated soils and pond bottom sediments. Periodic inspection and maintenance would address any significant settlement or other damage to the caps prior to exposure of the underlying tailings. The wet-closure cells are also very reliable in terms of minimizing direct contact, with periodic inspection and maintenance. With regular inspection and maintenance, the ground-water interception and pumpback system will effectively prevent offsite migration of any contaminated ground water. As discussed in more detail in Section 5.2.6, even complete failure of the pumping equipment would result in no measurable impact to offsite surface or ground water during the short time period during which any conceivable failure would be repaired.

Ability to Monitor Effectiveness of Remedy. The ground-water monitoring system for Alternative No. 6 is identical to that proposed for Alternative No. 5. The system will have the capability to establish the effectiveness of the ground-water hydraulic barrier, and monitor the quality of ground water up- and downgradient of the barrier. Taken together, the hydraulic and water quality data will fully monitor the effectiveness of the remedy in meeting ground-water ARARs. Additional discussion of the proposed monitoring system is provided in Section 7.2.

Availability of Equipment and Services. Equipment and services necessary to construct and operate this alternative are readily available in the area.

Availability of Technologies. The technologies required to implement and operate Alternative No. 6 are readily available. No new or unproven technology is required.

5.6.7 Cost

The estimated total construction cost, operation and maintenance cost and present worth of Alternative No. 6 are summarized in the following table. More detailed information on the cost bases for this alternative is presented in Appendix B.

ALTERNATIVE NO. 6		
Total Construction Cost	Operation and Maintenance Cost	Present Worth
$17,398,943	$55,000	$18,244,431

5.7 Alternative No. 7 (No Action)

5.7.1 Overall Protection of Human Health and the Environment

The potential for direct human and environmental contact with the tailings and associated soils and pond bottom sediments would not be changed from present conditions under the No Action alternative. The existing potential for continued migration of soluble metals contaminants from the tailings and sediments to the shallow aquifer would also remain unchanged. Although it does not appear that the existing ground-water quality presents an immediate or significant hazard to human health or the environment, occasional exceedances of MCLs for arsenic and cadmium would be expected to occur. It is possible that further development and migration of one or more contaminant plumes could occur, although the existing data are not adequate to fully assess this potential.

The No Action alternative would not address the potential for wind erosion and airborne migration of metals salts and or tailings and pond bottom sediments. The tailings and sediments would also continue to be subject to erosion caused by extreme flooding from the Mill-Willow Bypass or Warm Springs Creek and high runoff from the east hills. Damage or failure of the existing Pond 1 dikes resulting from earthquakes could occur. It is unlikely that more than a very small percentage of the total volume of tailings and pond bottom sediments in Pond 1 would be released offsite. The generally lower water table in the western portion of Pond 1, together with the small volume of ponded water in the eastern portion of the Pond, significantly reduce the potential mobility of these materials. However, prompt repair of any such damage would be required to avoid long-term runoff erosion or the potential for erosion and downstream transport during flood events.

Surface-water quality in the receiving streams below the site would continue to be subject to potential metals loadings due to runoff over soluble metals salts locally present on the surface of exposed tailings and pond bottom sediments.

5.7.2 Compliance With ARARs

Consistent compliance with all ARARs would not be achieved under Alternative No. 7 (No Action). Pond 1 does not presently comply with the flood and earthquake design standards for high hazard dams under Montana Dam Safety regulations. As noted in Section 2.1.2, Pond 1 is assumed for the purposes of this evaluation to classify as a high hazard dam. The area below Pond 1 does not comply with requirements under the Montana Solid Waste Act to be sited outside the 100-year floodplain or be designed to avoid washout during the 100-year flood. As noted above, occasional exceedances of ground-water MCLs have been recorded in wells on the

site and would be anticipated locally in the future under the No Action alternative. Surface-water ARARs may not be met at all times under this alternative.

5.7.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risk. Residual risks with no action would include the potential for offsite release of tailings and associated soils and/or pond bottom sediments due to wind, surface-water runoff or flooding, or earthquake-induced failure. The potential for direct contact would also remain. The potential exists for contaminated ground water leaving the site and either discharging to offsite surface water or remaining in the aquifer downstream of the site. Although none of these residual risks present catastrophic hazards to human health or the environment, it is not possible with the available data to accurately predict what the actual hazard levels are.

Adequacy of Controls. The only physical controls which presently exist are the periodic lime addition and seepage pumpback system in the lower Silver Bow Creek channel below the east end of the Pond 1 dike. Existing access controls limit the potential for significant, long-term human exposure to tailings and sediments, and prevent construction of drinking-water wells in contaminated ground water onsite. Maintenance and expansion of grassland vegetation are ongoing at the site.

5.7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Treatment Process Used. Treatment would consist of seasonal application of lime to surface water in Pond 1 and pumpback of seepage water downstream of Pond 1. Some natural biological treatment presumably occurs within the existing wetlands in and below Pond 1, but cannot be quantified.

Amount of Material Treated or Destroyed. The only contaminated media treated under Alternative No. 7 is a small portion of the ponded and seepage water in and below Pond 1. None of the contaminated material presently onsite would be destroyed.

Degree of Expected Reductions in Toxicity, Mobility, and Volume. No significant reduction in toxicity, mobility, or volume would occur under the No Action alternative.

Degree to Which Treatment is Irreversible. The lime addition and natural biologic treatment which would continue to occur are reversible due to fluctuations in water levels which lead to seasonal pH and oxidation variations and resulting dissolution of metals precipitates.

Type and Quantity of Residuals Remaining. Residuals from lime addition and natural biologic treatment of Pond 1 surface water and seepage are insignificant.

5.7.5 Short-Term Effectiveness

Protection of Community During Remedial Actions. No remedial action is proposed for the No Action alternative.

Protection of Workers During Remedial Actions. No remedial action is proposed for the No Action alternative.

Environmental Impacts. No environmental impacts would be experienced under the No Action alternative.

Time to Complete Remedial Actions. No remedial action is proposed for the No Action alternative.

5.7.6 Implementability

Ability to Construct and Operate. No remedial action is proposed for the No Action alternative. Current operation of the lime addition in Pond 1 and grassland management would be continued.

Reliability. The area would remain relatively stable and would not undergo significant change unless a major earthquake or large flood were to occur.

Ability to Monitor Effectiveness of Remedy. A monitoring system incorporating some of the existing wells onsite could be established to assess the effectiveness of natural processes (e.g., biologic activity, chemical attenuation) on ground-water quality, but is not proposed as part of this evaluation.

Availability of Equipment and Services. The equipment and services required for continued periodic operation and maintenance of the Pond 1 lime application system are readily available.

Availability of Technologies. No new or unproven technologies are utilized for the No Action alternative.

5.7.7 Cost

The cost to continue periodic lime addition at Pond 1 and manage grasslands is insignificant.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

6.1 General

This section presents a comparative analysis of all of the seven alternatives considered. This analysis includes seven of the nine criteria required by the NCP. The remaining two criteria, state and community acceptance of the alternatives for the remedial actions considered, will be addressed by EPA after the period for public comment is ended.

This evaluation considers only the proposed remedial actions for Pond 1 and the area below Pond 1. The area below the confluence of the Mill-Willow Bypass and the lower Silver Bow Creek channel is addressed separately in Section 7.1. Remediation of this area will be the same regardless of which alternative for Pond 1 and below is implemented.

The six action alternatives are comprised of three different methods for remediating the tailings and associated soils below Pond 1, and two for addressing pond bottom sediments within Pond 1. Combining these results in a total of six alternatives. It should be recognized however, that only three different remediation methods are proposed (wet closure/chemical fixation, dry closure, or removal) to achieve the remedial objectives for tailings and associated soils. Ground water is dealt with in a similar way for all of the alternatives.

6.2 Overall Protection of Human Health and the Environment

Each of the six action alternatives provides for a high level of protection of human health and the environment. No changes in the current exposures or risks would occur with the No Action alternative. No significant difference exists between the effectiveness of wet closure or dry closure with respect to accomplishing the objectives of the action. Dry closure will effectively prevent human and environmental contact, and migration of the contaminated material. This is also true with respect to wet closure in terms of human and terrestrial environmental exposure, since any direct contact with contaminated material would by necessity be for only a very short period of time. Development of aquatic life in the wet closures may be limited, but it should be noted that present conditions have not precluded development of an important fishery in Pond 3 and extensive waterfowl habitat throughout the WSP.

No significant difference can be demonstrated between wet and dry closure methods with respect to the potential for contamination of the underlying aquifer. Wet closure with lime pretreatment, coupled with the circulation of high pH water, will be effective in immobilizing the large majority of metals contained in the tailings. However, some limited, longer-term migration of metals could continue even after the initial flush of wet-closure water through the tailings or pond bottom sediments. Dry closure includes provisions for lowering ground-water levels beneath the tailings where the base of tailings are currently known or thought to be saturated. However, lowering the water level below the base of tailings may not be completely feasible due to irregularities in the depth of tailings or pond bottom sediments and natural variations in permeability of these and underlying soils. Furthermore, previously saturated tailings will continue to drain by gravity for an indeterminant period of time. Thus, the potential for limited, longer-term migration of metals to underlying ground water also exists for dry closure.

Alternatives No. 1 and No. 4, which include complete removal below Pond 1, reduce the area of tailings and associated soils by placing these materials within Pond 1. Complete removal below Pond 1 eliminates the ground water-tailings interface which currently exists. However, since it is not feasible to remove all tailings within Pond 1, the total area of potential contact with ground water is not sufficiently reduced to eliminate or acceptably minimize the risk of continuing ground-water contamination. Given this fact, ground-water interception systems are still required whether these tailings are removed or not.

Complete removal below Pond 1 in Alternatives No. 1 and No. 4 would also reduce the area within which there is any potential for human or environmental contact, as opposed to Alternatives No. 2, No. 3, No. 5 and No. 6. However, the risks for those alternatives with either wet or dry closure are reduced to insignificant levels. The same is true in relation to the potential for mobilization of the contaminated material. Complete removal would completely eliminate this risk for the area below Pond 1, whereas wet or dry closure would reduce the risk to minimal levels.

Wet closure of the area below Pond 1 and in the eastern third of Pond 1 under Alternative No. 5 would expand and enhance the existing waterfowl habitat and create higher value wetlands. Conversely, dry closure of all of Pond 1 and the area below (Alternative No. 3) or Pond 1 dry closure and removal in the area below (Alternative No. 1) will result in the significant negative environmental impacts of net loss of wetlands and reduction in waterfowl habitat. The remaining action alternatives are intermediate to the alternatives noted above in terms of environmental impact.

6.3 Compliance With ARARs

Each of the six action alternatives will comply with all ARARs for each of the four media of concern. As previously set forth, ARARs for remedial actions in Pond 1 and the area below include requirements related to dam safety, floodplain management, waste management, ground-water quality and surface-water quality. For purposes of this analysis, the Pond 1 dikes and/or the flood protection dike along the Mill-Willow Bypass which are part of each action alternative would provide 0.5 PMF flood protection and protection against a MCE as required under the dam safety ARAR. This level of protection is consistent with that provided for the much greater volumes of tailings and sediments contained within Pond 2 and Pond 3 upstream in the WSP Operable Unit. Containment of contaminated solid media within closures protected from the 100-year flood and wind erosion would meet floodplain and waste management ARARs. All action alternatives will meet ground-water ARARs by interception and treatment of any ground water exceeding MCLs which would otherwise flow offsite. Since all tailings and associated soils and pond bottom sediments will be dry closed, wet closed or removed, there will be no surface runoff from contaminated materials for any of the action alternatives proposed. Thus, surface-water quality ARARs will be met by all action alternatives. The No Action alternative would not fully meet any of the ARARs.

6.4 Long-Term Effectiveness and Permanence

6.4.1 Magnitude of Residual Risk

No significant differences exist in the magnitude of the residual risks following implementation of any of the action alternatives. Complete removal below Pond 1 (Alternatives No. 1 and No. 4) does not reduce the overall residual risks compared to either dry closure (Alternatives No. 3 and No. 6) or wet closure (Alternatives No. 2 and No. 5) of this area as might be expected. With either wet or dry closure, no significant risks remain relative to the potential for migration of the contaminants. The area will be completely protected from flooding, wind erosion, and human and terrestrial environmental contact. Offsite migration of ground water exceeding MCLs will be prevented by the operation of the ground-water

interception and treatment system. This system is necessary even if all tailings and associated soils are removed from the area below Pond 1 due to the initial and anticipated continued contribution of metals from the dry- and or wet/dry-closed tailings located in Pond 1. No significant residual risks have been identified for any of the six action alternatives.

6.4.2 Adequacy of Controls

Controls required for each of the six action alternatives are generally similar. The primary physical control required for each of the action alternatives is operation and maintenance of the ground-water interception and pumpback system. Alternatives No. 2, No. 4, No. 5 and No. 6 which utilize wet closure will also require operation and maintenance of the flow through the wet-closure cells. However, these operations would be integrated with the much more extensive controls required to operate Pond 2 and Pond 3 and their proposed wet closures. Somewhat more extensive access controls will be required for the alternatives incorporating wet closure, since these areas will be more desirable for recreation. Periodic inspection and maintenance will be required for the dry closures under all six action alternatives. The differences in areas of dry closure among the alternatives are not significant in terms of the level of effort required. Institutional controls to prohibit wells within the site area will be required for all alternatives unless or until monitoring confirms consistent compliance with ground-water ARARs.

6.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

6.5.1 Treatment Process Used

All six of the action alternatives include interception and pumpback to Pond 3 of ground water exceeding MCLs. The intercepted ground water will be treated by lime precipitation in the high pH water in Pond 3. This will result in effective immobilization of dissolved or soluble metals in the ground water.

Alternatives No. 2, No. 4, No. 5 and No. 6 all include wet closure/chemical fixation of a portion of the tailings and sediments within and/or below Pond 1. The chemical-fixation treatment includes application/mixing of lime prior to inundation, and subsequent circulation of high pH water through the wet-closure cells. These treatment processes will immobilize the large majority of dissolved or soluble metals in wet-closed tailings or pond bottom sediments, and also within underlying ground water over time. Natural biologic activity within the wet-closure cells will also act to treat metals to some degree.

Alternatives No. 1 and No. 3 propose no treatment of tailings and associated soils or pond bottom sediments.

6.5.2 Amount of Material Treated or Destroyed

As noted in the previous subsection, all six action alternatives propose interception and treatment of ground water. Although the amount of ground water treated may vary somewhat among the alternatives, the differences are not significant in terms of comparisons.

Alternative No. 5 would treat the greatest area and volume of tailings and associated soils and pond bottom sediments through chemical fixation of dissolved or soluble metals. Alternatives No. 2, No. 4 and No. 6 would treat less, but generally comparable areas of these media. Wet closure of the eastern third of Pond 1 in Alternatives No. 4 and No. 6 would potentially treat greater volumes due to the generally greater thickness of tailings and sediments as compared to the area below Pond 1 wet closed under Alternative No. 2.

Alternatives No. 1 and No. 3 would not treat any tailings or sediments, and none of the six action alternatives would destroy any contaminated media.

6.5.3 Degree of Expected Reductions in Toxicity, Mobility, and Volume

Toxicity of the tailings and associated soils and pond bottom sediments located below the wet-closed areas will be reduced by implementation of Alternatives No. 2, No. 4, No. 5 and No. 6. Reduction of toxicity is accomplished by chemically fixing dissolved or soluble metals in a less soluble state through lime treatment and maintenance of a high pH environment.

The potential for mobilizing the tailings and associated soils and pond bottom sediments due to wind, floods or earthquakes is reduced to insignificant levels for all six action alternatives. No advantage to removing the tailings below Pond 1 as proposed in Alternatives No. 1 and No. 4 is apparent, nor is there any significant difference between wet- and dry-closure methods among the other alternatives as they are proposed. Mobility of the tailings and/or sediments caused by runoff or wind erosion is prevented by providing flood protection facilities and by covering the material with water or soil. Mobility due to earthquake-induced failure is minimized by structural remediation of existing dikes, and/or construction of new earthquake-resistant dikes. Intercepting ground water exceeding MCLs will prevent offsite contamination from this source under all six alternatives.

None of the alternatives evaluated will reduce the volume of pond bottom sediments and tailings and associated soils. Contaminated ground water beneath the site will be intercepted and treated prior to migrating offsite in each action alternative. This will result in a reduction of the volume of contaminated ground water over time. Although the volumes of metals removed from ground water by treatment will vary somewhat among the alternatives, the differences are not significant in terms of comparisons.

6.6 Short-Term Effectiveness

6.6.1 Protection of Community During Remedial Actions

The greatest risks to the community are those associated with the greatest amount of construction activity and the longest duration of intense construction effort. Generally speaking, the most costly construction actions involve the highest level of activity. Alternatives No. 1 and No. 4, which include the complete removal of tailings and associated soils below Pond 1, pose the highest risk to the surrounding community and environment. This risk relates to the higher potential for contamination of the underlying shallow aquifer and adjacent surface waters during the removal process. Otherwise no significant difference in risk to the community exists among

any of the alternatives. All of the alternatives would incorporate appropriate controls of construction-related dust and increased traffic to minimize impacts to the community.

6.6.2 Protection of Workers During Remedial Actions

None of the proposed six action alternatives involves any activities which present significant health risks to workers. Those alternatives which require the most handling of contaminated materials obviously pose the highest risks relative to worker exposure. However, none of the alternatives have unacceptably high risks associated with them. Workers will be protected using appropriate protective equipment and will be required to have 40-hour health and safety training prior to beginning work on the site.

6.6.3 Environmental Impacts

There are major differences among the alternatives with respect to environmental impacts. Alternatives No. 1 and No. 4, which propose complete removal below Pond 1, would result in the permanent degradation of a large existing wetlands area. This degradation would be permanent, as removal of the relatively impermeable material overlying the very permeable aquifer, coupled with lowering of the water table by the ground-water interception trench, would make it impractical to reconstruct the wetlands to current or enhanced values. Those alternatives which propose dry closure of the eastern third of Pond 1 (Alternatives No. 1, No. 2 and No. 3) would result in the permanent loss of existing wetlands by draining the area and placement of an earthen cap. Alternatives No. 1 and No. 3, which propose dry closure of all of Pond 1 coupled with removal or dry closure below Pond 1, result in the greatest loss of wetlands. Alternative No. 5, on the other hand, maximizes the area of enhanced wetlands both within and below Pond 1. Alternatives No. 4 and No. 6 expand and enhance waterfowl habitat and improve the value of existing wetlands in the eastern third of Pond 1, while Alternative No. 6 does the same below Pond 1.

All of the action alternatives would create a positive environmental impact by establishing grassland habitat in the presently unvegetated areas of exposed tailings or pond bottom sediments in the western portion of Pond 1.

6.6.4 Time to Complete Remedial Actions

All of the proposed action alternatives can be fully implemented over a two-year construction period. However, Alternatives No. 1 and No. 4 would require a significantly higher level of activity during the construction period to accomplish the complete removal of tailings and associated soils from below Pond 1. This is also true to a lesser degree of those other alternatives proposing full dry closure of Pond 1 (Alternatives No. 2 and No. 3).

6.7 Implementability

6.7.1 Ability to Construct and Operate

The most difficult alternatives to construct are those which include complete removal of all material below Pond 1 and for dry closure of all of Pond 1. These include Alternatives No.

1 through No. 4. Complete removal below Pond 1 will require very extensive dewatering efforts and physical controls to prevent the escape of contaminated material offsite during the removal process. The specific measures required will be determined during Remedial Design. However, it is clear at this time that considerable care will need to be taken to reduce the potential of offsite excursions of tailings and associated soils and contaminated water to acceptable levels.

Construction of the dewatering trench within Pond 1 proposed in Alternatives No. 1, No. 2 and No. 3 will also be difficult due to the saturated, soft soil conditions present. It is expected that the tailings are completely saturated so that surface access and trafficability by conventional construction equipment will be impossible. Special equipment will be required to undertake the excavation and redistribution of the excavated material.

None of the six action alternative present any special operational problems. All of the alternatives include ground-water interception, which requires pumping the intercepted water to Pond 3 for treatment. This requires regular operation, inspection and maintenance under all action alternatives to ensure that the system functions as intended. Operation of the wet-closure cells under Alternatives No. 2 and No. 4 through No. 6 will be relatively simple and straight forward. This will require control of flow through the cells to ensure that the ponds remain at the proper operating level. Regular inspection and periodic maintenance would be performed to insure proper operation.

Those alternatives which consist only of dry closure and/or removal (Alternatives No. 1 and No. 3) will be easier to operate than those which utilize wet closure (Alternatives No. 2 and No. 4 through No. 6). Wet-closure systems will require that water-flow through the system be controlled, which means that periodic operator attention will be required. However, since other aspects of the remediation under these alternatives will also require monitoring and routine or periodic maintenance, the incremental effort to operate the wet closures will not represent a significant increase over that required for other aspects of the overall system. Furthermore, historic operation of the WSP for waterfowl management has required operational control of flows to various parts of the system. The proposed wet closures will be an extension of that type of operation and should not present any unique problems.

6.7.2 Reliability

Very little difference is apparent in the anticipated reliability among the six action alternatives evaluated. All of the alternatives provide an essentially equal degree of reliability with respect to the specified remediation objectives. Each alternative includes similar provisions to prevent the migration of contaminated ground water offsite. Even alternatives which include removal below Pond 1 still require that ground water be intercepted initially, and potentially over the long-term. Regular inspection and maintenance will result in high reliability of the ground-water interception and pumpback system for all action alternatives.

All of the action alternatives provide high reliability in terms of eliminating or reducing to insignificant levels the potential for human or environmental exposure to tailings and associated soils or pond bottom sediments. The wet or dry closures proposed under all alternatives are protected from floods up to the 0.5 PMF and earthquakes up to the MCE. Both

closure methods are highly reliable given regular inspection and periodic maintenance as required.

The remediation methods proposed for tailings and associated soils, pond bottom sediments and ground water will provide very reliable protection against contamination of adjacent surface waters for all alternatives evaluated.

6.7.3 Ability to Monitor Effectiveness of Remedy

All six of the action alternatives evaluated include provisions to monitor compliance with ground-water ARARs. This includes installation of monitoring wells both up- and downgradient of ground-water interception trenches. These would be measured for water level to establish that an effective hydraulic barrier exists, and sampled for compliance with MCLs. The ability to monitor the effectiveness of the remedy is the same for all alternatives.

6.7.4 Availability of Equipment and Services

Equipment and services necessary to construct and operate any of the six action alternatives are readily available in the area. The only potential difference among alternatives in this regard involves the actual method of excavation related to removal below Pond 1 and/or dewatering of the eastern third of Pond 1 under Alternatives No. 1 through No. 4. If dredging were selected during Remedial Design, it would be necessary to import equipment and operators experienced with this technique from outside the area.

6.7.5 Availability of Technologies

The technologies necessary to implement any of the action alternatives are readily available. No new or unproven technology is required for any of the alternatives evaluated.

6.8 Cost

The estimated costs of the six action alternatives are summarized in Table 6-1 below. The total construction cost (including Division 1 costs and contingencies) of the six action alternatives ranges from $16,578,211 for Alternative No. 5 to $30,977,008 for Alternative No. 1. Alternative No. 5 has the highest annual operation and maintenance cost ($70,000); the lowest operation and maintenance cost ($25,000) is anticipated for Alternative No. 1. The resulting present worth costs range from a low of $17,654,286 for Alternative No. 5 to $31,381,321 for Alternative No. 1. Detailed information regarding the costs for each alternative is presented in Appendix B.

The lowest cost alternative both in terms of total project cost and present worth is Alternative No. 5. The estimated cost for Alternative No. 6 is only marginally greater (less than five percent on either a total project or present worth basis). It is apparent that those alternatives involving removal below Pond 1 and/or full dry closure of Pond 1 are significantly more costly, even when annual operation and maintenance costs are included. The costs of Alternative No. 1 through No. 4 range from 78 percent to 35 percent more than the cost of Alternative No. 5 on a present worth basis.

TABLE 6-1

ALTERNATIVES COST COMPARISON

	Total Construction Cost	Operation & Maintenance	Project Present Worth
Alternative No. 1	$30,977,008	$25,000	$31,381,321
Alternative No. 2	$25,092,680	$50,000	$25,861,305
Alternative No. 3	$25,762,212	$35,000	$26,300,250
Alternative No. 4	$23,181,839	$45,000	$23,873,602
Alternative No. 5	$16,578,211	$70,000	$17,654,286
Alternative No. 6	$17,398,943	$55,000	$18,244,431

7.0 OTHER CONSIDERATIONS

7.1 Remediation of Overbank Tailings

Tailings and associated soils are present along Silver Bow Creek from its confluence with the Mill-Willow Bypass in the area below Pond 1 north to the Operable Unit boundary at the county road (see Figure 2-1). As noted in Section 2.3.1, this area is not included in the assembly or evaluation of alternatives for Pond 1 and the area below. Rather, this area is proposed as a demonstration area for remediation of overbank tailings as described below.

The large majority of tailings in the demonstration area are overbank deposits adjacent to the channel of Silver Bow Creek. A small fraction of the total tailings in this reach locally overlie the steep banks of the channel. Within the WSP Operable Unit, the areas of unvegetated overbank tailings (i.e., slickens) have been bermed to mitigate flushing of metals salts into Silver Bow Creek from direct rainfall runoff.

Interim additional remediation of the area is proposed pending the results of ongoing studies for the Streamside Tailings Operable Unit. The interim remediation proposed is a modified version of the Governor's Project which has already been implemented along the Clark Fork River below the Warm Springs Lane bridge. The objective of the remediation proposed is to immobilize soluble metals within the tailings and associated soils. This would eliminate or minimize to the extent possible the wicking of metals to the surface and subsequent precipitation of soluble metals salts. Also, the leaching and transport of metals in ground water would be controlled.

The remediation would be implemented by first clearing all areas of overbank tailings of existing vegetation. Then a combination of burnt lime and agricultural lime would be disced/deep-plowed into the tailings to a depth equal to the depth of the tailings, but not to exceed 48 inches. The surface of lime-treated areas would then be fertilized as necessary and

revegetated with native species of grasses and shrubs. The deep-plowing application of lime would avoid the steep banks of the creek to minimize the potential of sedimentation of the channel. The banks would be treated by pressure injection of a milk of lime slurry. Injection would be performed through a perforated injection needle to the full depth of tailings and associated soils on the banks. Injection equipment would access the banks from the overbank area, and appropriate care would be taken to minimize sedimentation of the creek.

This interim approach would effectively control metals loadings to Silver Bow Creek in this reach believed to be the result of runoff over soluble metals salts. It would also be effective in significantly reducing the potential for metals loading to shallow ground water underlying the overbanks. The methods and areas of treatment proposed would avoid significant disturbance of the well-developed fishery in this reach of Silver Bow Creek, while effectively remediating the very large majority of tailings and associated soils present.

7.2 Ground-Water Monitoring

Alternatives No. 1-6 have four components in common. Tailings and associated soils would remain onsite, shallow ground water beneath and downgradient of Pond 1 may remain contaminated above health-based levels (MCLs) for arsenic and cadmium for an undetermined length of time, contaminated ground water would be intercepted so it would not migrate offsite, and ground-water monitoring would be implemented. Long-term ground-water monitoring would be used to monitor future conditions and to assess the effectiveness of the final action.

Either eight or sixteen new monitoring wells would be installed in the shallow aquifer onsite depending on the final action. These wells would be installed along each interceptor trench below Pond 1, four on the upgradient side of each trench and four on the downgradient side of each trench. Alternatives No. 1, No. 4, No. 5, and No. 6 would include eight new wells because one interceptor trench would be used below Pond 1. The trench would be located along either the toe of Pond 1 (Alternative No. 4) or the existing alignment of the Mill-Will Bypass (Alternatives No. 1, No. 5 and No. 6). Sixteen new wells would be used for Alternatives No. 2 and No. 3 because there would be two interceptor trenches, one along the toe of Pond 1 and the other along the existing alignment of the Mill-Willow Bypass below Pond 1.

Water level and analytical results from the new wells, some of the existing wells onsite, and each interceptor trench would be used to monitor future conditions and to assess the effectiveness of the interception system to minimize the further migration of contaminated ground water beyond the trench location(s). Sampling would be conducted three times per year (sampling during the very cold winter season would be avoided). Samples would be analyzed for arsenic, cadmium and lead and compared with respective health-based MCLs. Water levels from the wells on both sides of each trench and in each trench would be used to confirm that the trench functions as an effective hydraulic barrier to the natural flow direction of contaminated ground water. Figures 3-1 and 3-5 show the alternative locations for interception trenches and Figures 7-1 and 7-2 are typical cross sections of interception trenches with adjacent monitoring wells that would be used upgradient of a new Bypass channel and/or along the downstream toe of Pond 1.

If the monitoring results indicate the interception system is ineffective, appropriate investigative and remedial action(s) would be initiated as necessary. If the monitoring results ultimately indicate the shallow ground water intercepted by the trench consistently meets remediation goals, operation of the interception and treatment system may be discontinued. This scenario would apply to the interception and treatment system only used to control the further migration of contaminated ground water without site dewatering (MSA 4B and 4C, Alternatives No. 4-6), and would involve discontinued pumping to allow the trench to fill so that the natural ground-water level and flow direction would be reestablished.

In the case of Alternatives No. 1-3, the interception system within and along the downstream toe of Pond 1 (MSA 4A) would continue to be used regardless of future water-quality conditions because it would be required to maintain the water table beneath Pond 1 at a level below the pond bottom. The assemblage of media-specific actions for Alternatives No. 1-3 assumed that further contamination of ground water beneath Pond 1 would be controlled by lowering the water table so that ground water would no longer come in direct contact with pond bottom sediments. However, if the quality of ground-water flow from beneath Pond 1 intercepted by the toe trench remains below health-based and other surface-water quality ARARs, the water may be discharged from the trench to the Mill-Willow Bypass without further treatment.

7.3 Proposed Soils Remedial Action Protocol

The remedial action objective for tailings and associated soils and pond bottom sediments is to reduce the potential for human and environmental exposure to these materials. Because there are no ARARs for soils, the approach used for the Mill-Willow Bypass Removal Action to verify achievement of the objective would be a component of the final action for the Pond 1 area. It would be used to determine the amount of tailings and associated soils that would be designated for containment in wet- or dry-closure areas and/or removed from below Pond 1, and to identify appropriate borrow materials for construction of wet-closure area dikes and dry-closure area caps, as necessary.

Verification of the remedial action objective would involve the visual identification of contaminated materials based on such typical physical attributes as color and texture and the sampling and analysis of soils. Soils would be screened for copper levels by X-ray Fluorescence analysis of samples in a field laboratory during construction to expedite implementation of work related to the remedial action objective. Materials containing copper in concentrations greater than 500 mg/kg would not be used for construction of dikes or caps. Soils that would be exposed after the removal of tailings and contaminated soils and materials used for dike and cap construction are expected to contain low concentrations of arsenic, cadmium, copper, lead, and zinc, similar to those in soils exposed after completion of the Bypass removal work. (See post-removal analytical results summarized in Table 7-1.)[17] To confirm the effectiveness of the remedial action, soil samples would be analyzed for arsenic, cadmium, copper, lead, and zinc by an analytical laboratory.

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[17] ESA Consultants, 1991. Soils Removal Report Mill-Willow Bypass Removal Action, Warm Springs Ponds Operable Unit, Warm Springs, Montana: report prepared for Atlantic Richfield Company.

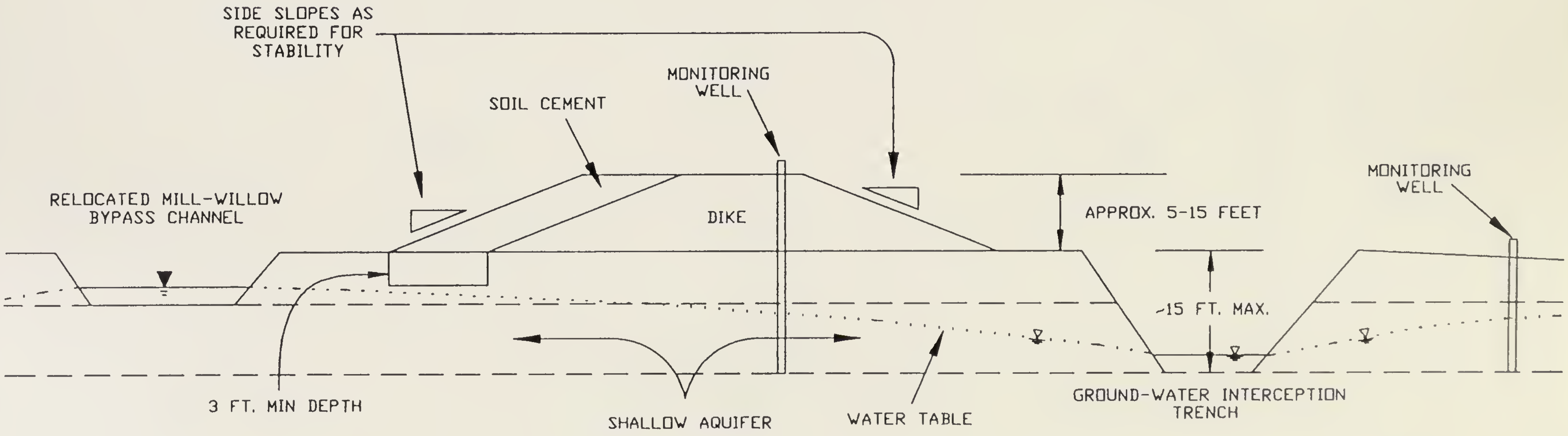
TABLE 7–1

STATISTICAL SUMMARY OF ANALYTICAL DATA BY MATERIAL TYPE PRE–REMOVAL AND POST–REMOVAL CONFIRMATION ANALYSES MILL–WILLOW BYPASS REMOVAL ACTION

PARAMETER & STATISTICS	PRE–REMOVAL DATA			POST–REMOVAL DATA	
	1 TAILINGS & ASSOCIATED SOILS	2 PROPOSED BORROW MATERIAL	3 BYPASS SOILS AT GRADE PROPOSED	4 BYPASS SOILS AT GRADE ATTAINED	5 BORROW MATERIAL USED
ARSENIC					
Minimum	22	6 U	6 U	8.4 U	8.2
Maximum	2750	92.7	17.2	42.1	94
Mean	244	17.3	8.6	14.8	22.5
Std Deviation	411	16.5	3.8	7.8	22.1
n	81	27	20	100	44
CADMIUM					
Minimum	0.4 U	0.4 U	0.4 U	0.8 U	0.8 U
Maximum	166	4.3	4.2	4	2.2
Mean	9	0.9	1.9	1.1	1.0
Std Deviation	22.6	1.1	1.6	0.6	0.3
n	81	27	20	100	44
LEAD					
Minimum	16.5	4 U	4 U	8.4 U	8.2 U
Maximum	1630	30.3	19.8	45.5	122
Mean	238	10.4	6.1	16.3	20
Std Dediation	239	7.3	4.1	7.6	20.9
n	81	27	20	100	44
COPPER					
Minimum	142	11.9	7.1	0.6 U	7.2 U
Maximum	66300	461	65.6	287	447
Mean	2758	83	21.1	64.7	74.6
Std Deviation	7934	113	18.1	54.1	95.5
n	81	27	20	100	44
ZINC					
Minimum	109	18.3	15.6	0.4 U	16.9 U
Maximum	41000	567	277	573	365
Mean	1996	113	46.5	124.4	74.3
Std Deviation	5066	134	64.7	117.1	68.9
n	81	27	20	100	44

U = Less than instrument detection limit

All values in milligrams per kilogram, except n, which is the number of samples analyzed.



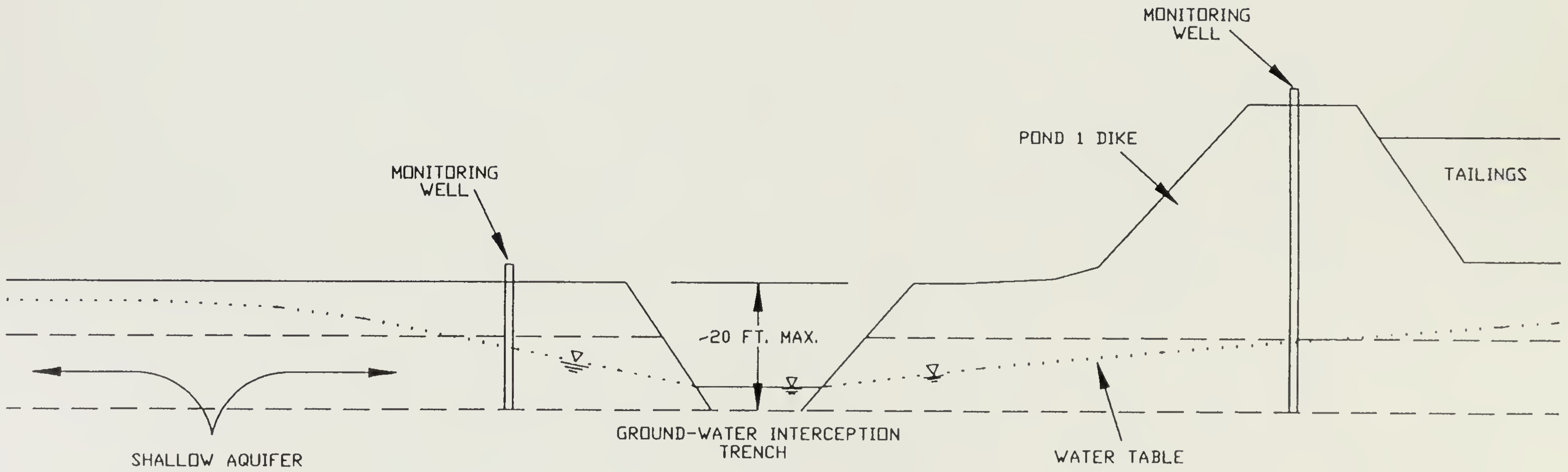
SCHEMATIC ONLY - NOT TO SCALE

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

CONCEPTUAL GROUND-WATER MONITORING PLAN
AREA BELOW POND 1

Figure 7-1

EP17-1.dwg



SCHEMATIC ONLY - NOT TO SCALE

EVALUATION OF ALTERNATIVES FOR POND 1 AND BELOW

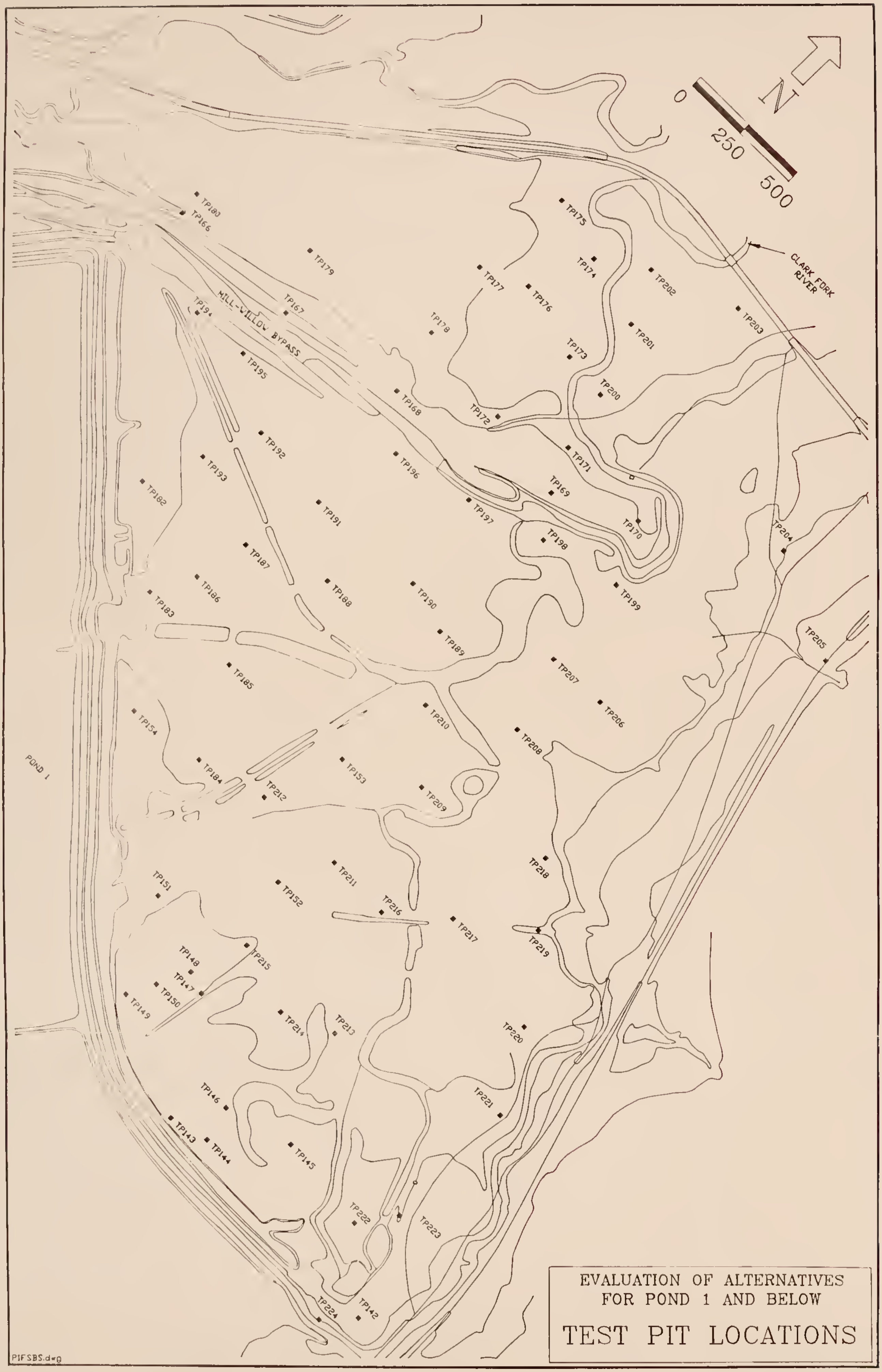
CONCEPTUAL GROUND-WATER MONITORING PLAN TOE OF POND 1 DIKE

Figure 7-2

EP17-2.dwg

APPENDIX A

SUPPLEMENTAL FIELD EXPLORATION DATA



EVALUATION OF ALTERNATIVES
FOR POND 1 AND BELOW

TEST PIT LOCATIONS

ESA Consultants

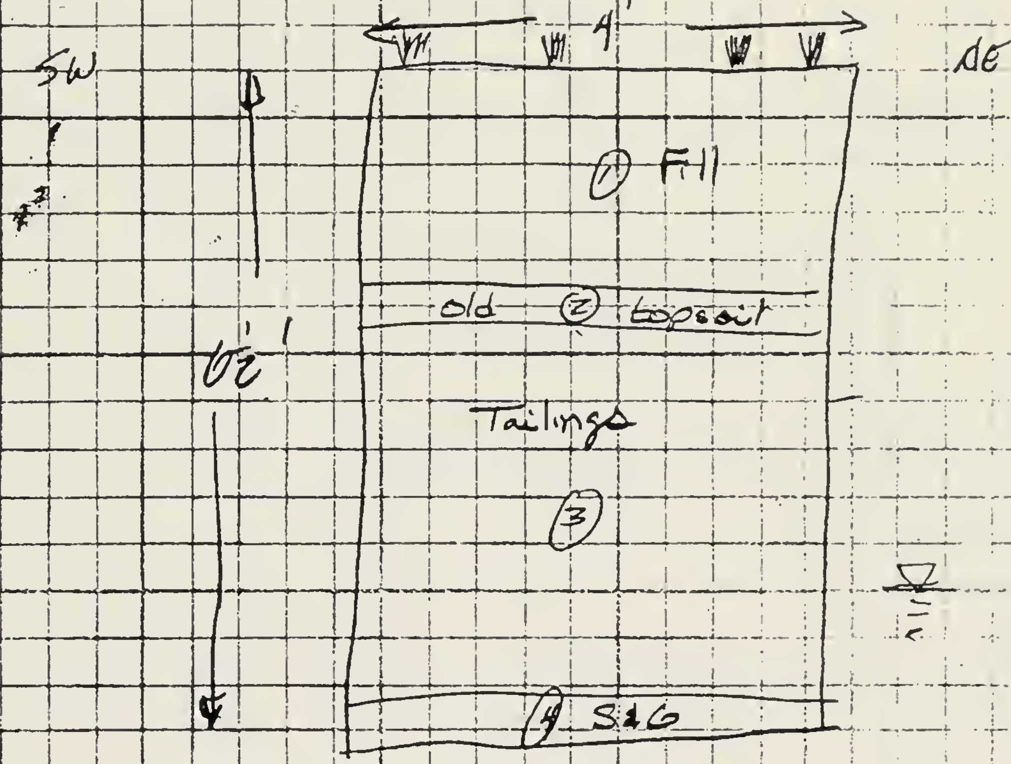
JOB NO. 3381-7A SUBJECT TP-142 SHEET NO. 1 OF 1

PROJECT WARM SPRINGS PONDS NORTH OF POND No. 1 BY AJP DATE 12/17/90

TP-142: ~100' N. OF OLD LIME SHACK, 0' E. @ Pond 1
coordinates: 810880N, 1173980E Cfp

KUBOTA TRACTOR, JOHN CLARK: OPERATOR

STARTED 9^{30} AM FINISHED



Back Filled E/P

0'-2½'
① SILTY SANDY FILL BROWN TO RED-BROWN, 20-30% FINES, WELL GRADED SAND w/ NO GRAVEL, TOP 6" ROOT ZONE, TOP 6" FROZEN.

2½'-3'
② TOPSOIL, BLACK TO DK BROWN, SILTY SAND, HIGH ORGANIC CONTENT, SATURATED

③ 3'-6' TAILINGS, FINE GRAINED SLIMES (BROWN/BLACK) TO COARSE SAND TAILINGS (RED/ORANGE). BECOMES GRAY w/ DEPTH BELOW GWT.

6-6½'
④ GRAVEL AQUIFER, SANDY GRAVEL, BROWN, < 10% SILT & CLAY, MEDIUM TO COARSE SAND, LITTLE GRAVEL & COBBLES, SATURATED

GWT @ 5' & STABLE, BOILING OF WATER @ 6½' DURING INITIAL EXCAVATION

ESA Consultants

JOB NO. 3301-7A SUBJECT TP 143 SHEET NO. 1 OF 2

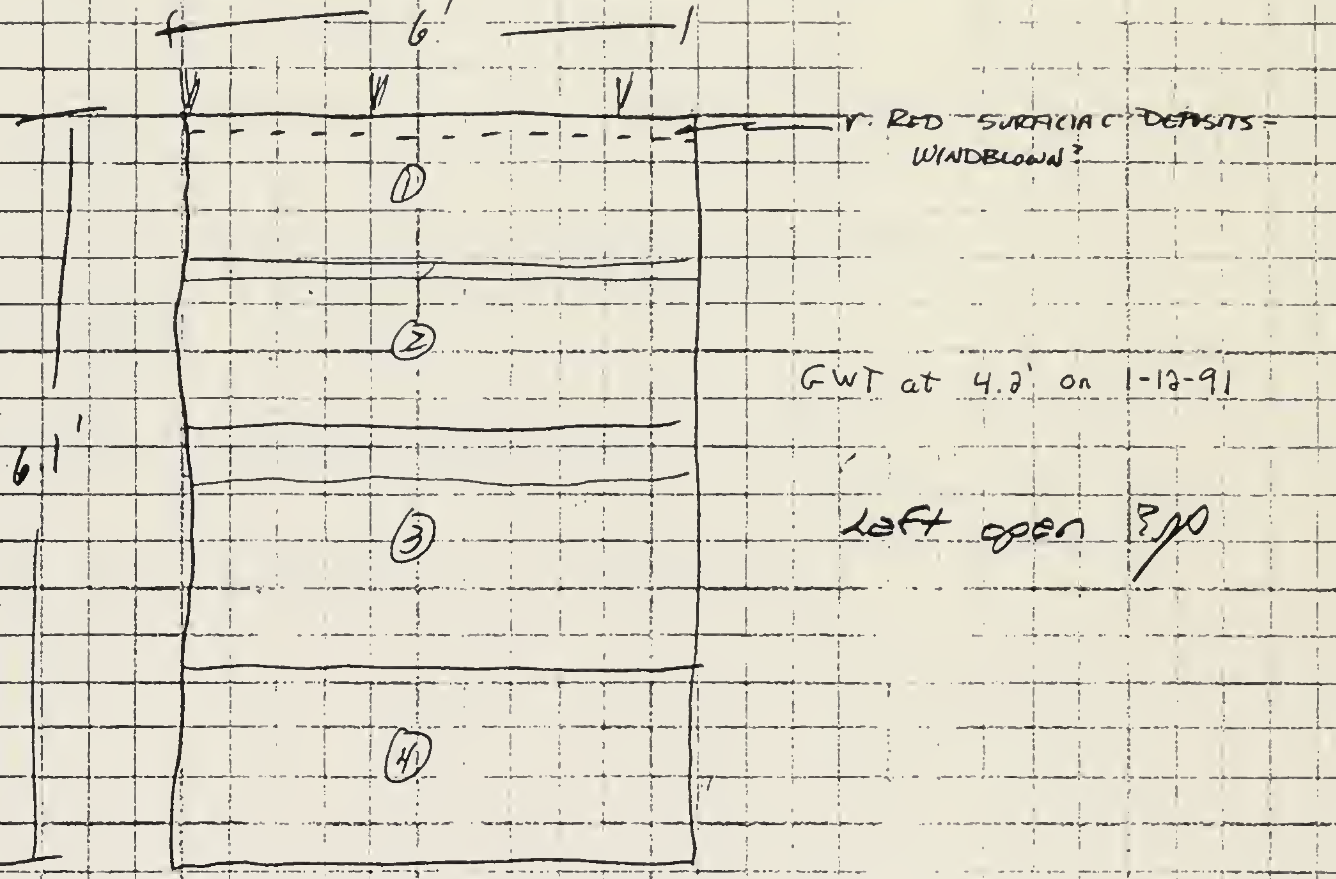
PROJECT WARM SPRINGS PONDS NORTH OF POND NO. 1 BY AJP DATE 12/17/90

12-17-90 TP 143, 15' N. OF POND NO. 1 CUT-OFF TRENCH, ~1000' W. OF E. ABUTMENT

Coordinates: 810904N, 1172986E

KUBOTA TRACTOR, JOHN CLARK - OPERATOR

START EX: 2^{45} pm END 3^{20} pm



GWT at 4.2' on 1-12-91

Left open 3/10

① 0'-1' : VERY ORGANIC RICH TOPSOIL, RED TO ORANGE. FINE TO MED. SAND W/ SILT, VERY IRON RICH. APPEARS FE IS REPLACEMENT ELEMENT IN WOOD CHIPS. DRY.

② 1'-2.4' TOPSOIL, BROWN/BLACK TO GRAY. 40-50% SILTY FINES, 40-50% FINE TO MEDIUM SAND. LOOSE, ROOTS & OTHER ORGANICS, MOIST. TOP 1"-2" - LENSE OF WHITE, UNIFORM MEDIUM SAND. MOTTLED W/ RED FE FLAKES, DRY.

③ 2.4'-4.7' POORLY GRADED MEDIUM SAND, 15-20% FINES, LOW PLASTICITY, FINE TO MEDIUM SAND W/ SCATTERED COBBLES. TOP OF LAYER CONTAINS 4"-5" LENSE OF MORE CLAYEY SAND, WHITE TO BUFF, 30-40% LOW-MED. PLASTIC FINES 40-50% WELL GRADED FINE-COARSE SAND. 5-7% SCATTERED GRAVEL & ~~FM~~ SM. COBBLES. DENSE, MOIST.

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JOB NO. 3381-7A SUBJECT TP 143 CONT SHEET NO. 2 OF 2

PROJECT WSP NORTH OF POND No. 1 BY DATE 12/17/90

④ 4.7'-6.1' : SANDY GRAVEL, GRAY, 5-10% FINES, 20-40% WELL GRADED SAND, MOTTLED, 40-60% Sm TO LARGE GRAVEL W/ SCATTERED 3+" COBBLES, SATURATED

G.W.T @ 5.7' @ 3^{25} pm → hole left open

PHOTO'S : ROLL 1 :

#1: RED SOIL @ TOP OF EXCAVATED SECTION, LOOKING S.

#2: TRENCH, LOOKING W.

#3: TEST PIT VICINITY, LOOKING W.

G.W.T @ 4.3' (frozen) on 12-21-90

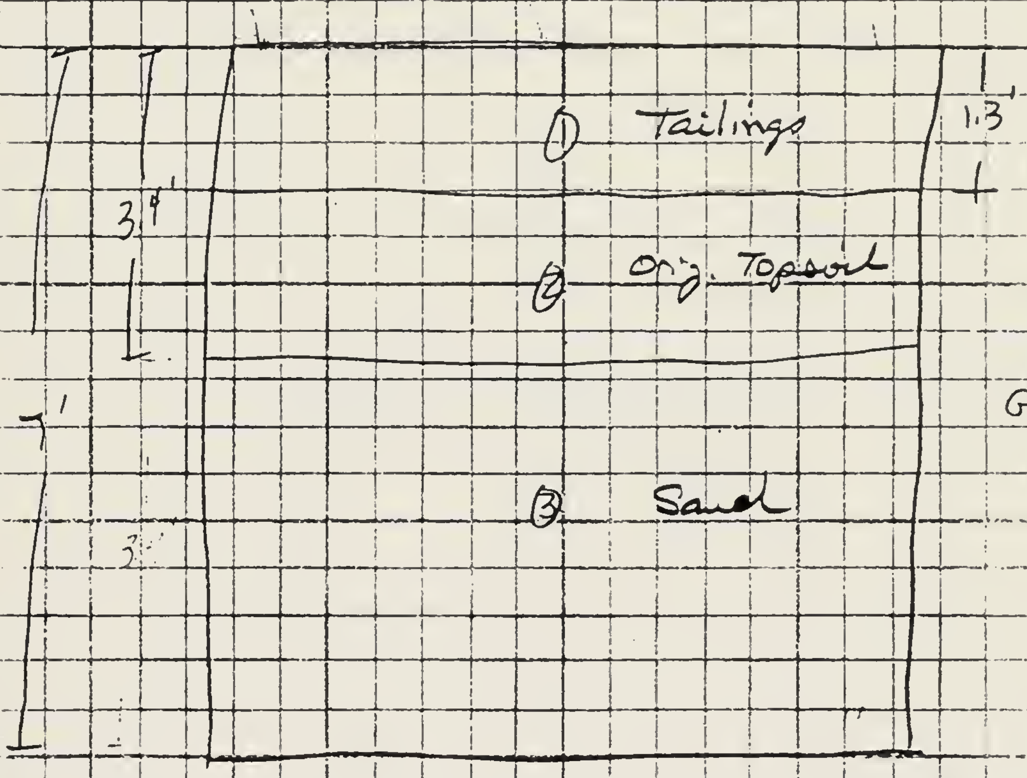
ESA Consultants

JOB NO. 3381-7A SUBJECT TP-144 SHEET NO. 1 OF 1
PROJECT WARM SPRINGS PONDS NORTH OF POND No. 1 BY JJP DATE 12/17/90

12-17-90 TP-144, 50' N. OF CUT-OFF TRENCH, ~150' E. OF TP-143 Coordinates: 810943N, 1173132E EJS

KUBOTA TRACTOR, JOHN CLARK - OPERATOR

START: 3^{35} PM END: 4^{07} PM



GWT at 4.0' on 1-12-91

Left open EJS

① 0'-1.3' : POORLY GRADED SAND (TAILINGS), BUFF TO ORANGE, < 5% FINES, FINE TO MEDIUM SAND, POORLY GRADED, LOOSE TO V. DENSE LENSES, ORANGE/RED STAINS, DRY. NO $CaCO_3$

② 1.3'-3.4' BLACK TOPSOIL, 70-80% SILTY FINES, 20-30% FINE TO MEDIUM SAND, MOIST, THICK ROOT ZONE.

③ 3.4'-7' : POORLY GRADED SAND, OLIVE GRN, MAROON, BLACK (DARKENS BELOW GWT), 0-5% FINES, 90-95% FINE-MED GRAINED SAND, LOOSE, SATURATED. (REDUCED TAILINGS ?)

GWT @ 5.3' AT 4^{00} PM (TOP OF SEEP)

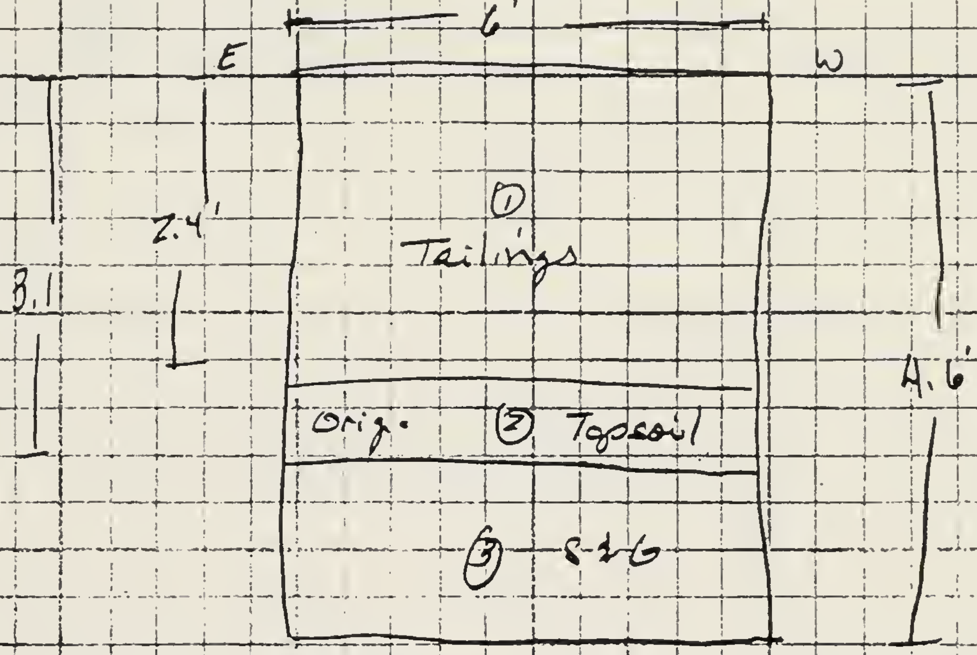
PHOTO'S: ROLL #1
#4 EXCAVATION SPOIL PILE #5 : TRENCH

1 SM BAG 3.4'-5'

JOB NO. 3381-7A SUBJECT TP-145 SHEET NO. 1 OF 1
PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP-145 : EXPOSED TAILINGS, 700' W AND 400' N. OF SHACK @ POND 1 DIKE
Coordinates: 81148N, 117 3355E EJD
CASE 580 C BACKHOE OPERATED BY JOHN CLARK

START EX : 10^{30} AM COMPLETED LOG : 11^{00} AM



Backfilled EJD

① 0'-2.4' TAILINGS, ORANGE TO RED, 15-25% FINES, WELL GRADED SAND TO MED. GRAVEL, MOIST, TOP 6" FROZEN.

② 2.4'-3.1' TOPSOIL, BLACK, 70-80% FINES, LOW PLASTICITY, NUMEROUS ROOTS, MOIST TO SATURATED.

③ 3.1'-4.6' SANDY GRAVEL, GRAY-BLACK, 5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL, 5-10% COBBLES, SATURATED.

GWT @ 4' AND RISING SLOWLY @ 10^{55} AM

PHOTO'S - ROLL #1

#9 : VICINITY OF T.P. - LOOKING E.

#10 : TRENCH - LOOKING E.-W

GWT @ 3.4' (Frozen) on 12-21-90

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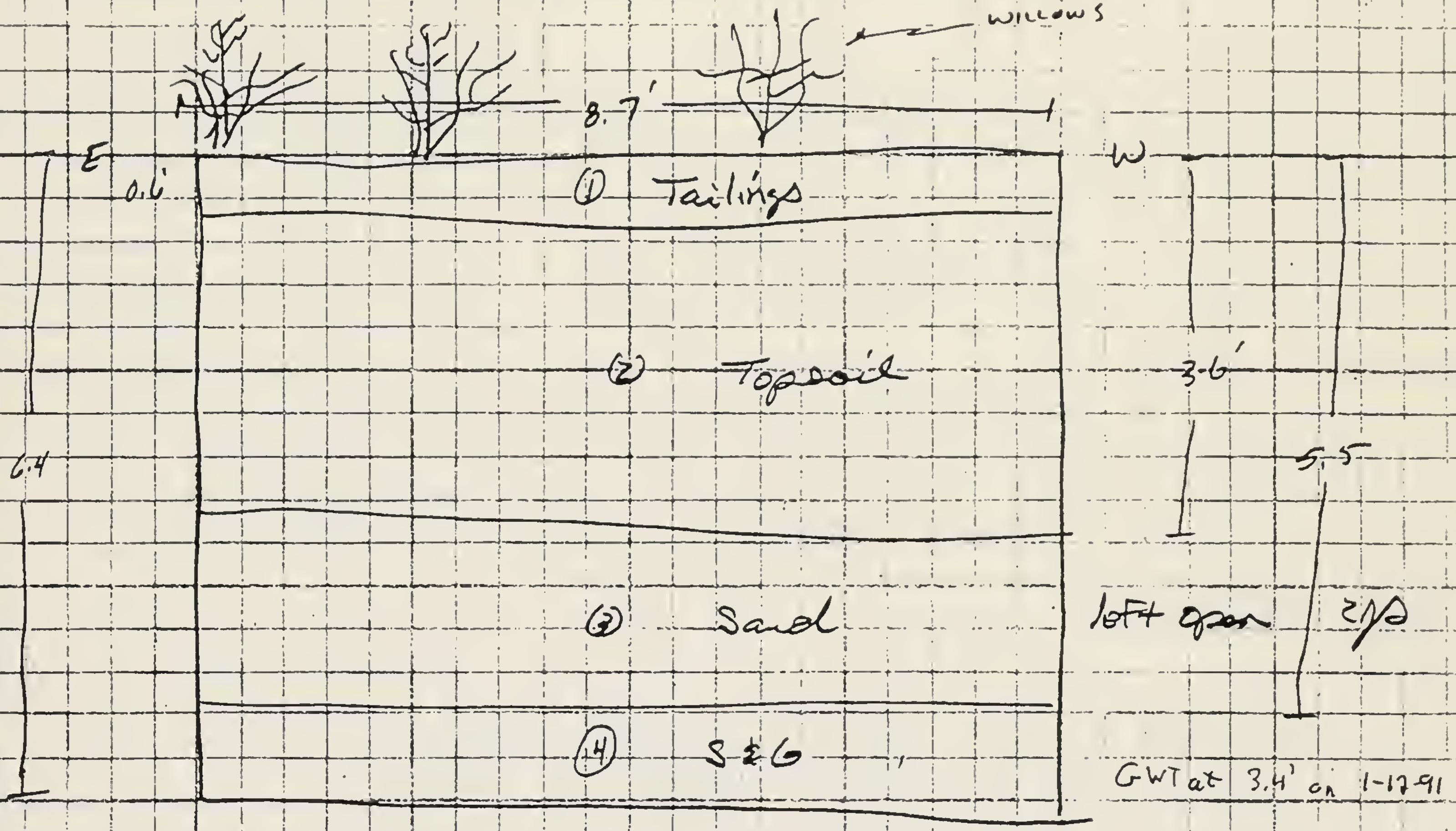
JOB NO. 3381-7A SUBJECT TP146 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP-146: BELOW DENSE WILLOW GROWTH, 200' W. OF TP 145 ~150' NE Pond 1 toe trench
Coordinates: 811073 N, 1173097 E
CASE 580C BACKHOE OPERATED BY J. CLARK

STARTED EX: 11^{15} AM FINISHED LOG: 11^{35}



GWT at 3.4' on 1-17-91

① 0'-0.6' TAILINGS, BUFF TO RED/ORANGE, 30-40% FINES, 60-70% FINE TO MED SAND, POORLY GRADED, MOIST, LOOSE

② 0.6'-3.6' TOPSOIL, BLACK, 70-80% FINES, LOW PLAST., 20-30% FINE-MED SAND, CONSIDERABLE # OF ROOTS, MOIST, SLOUGHING.

③ 3.6'-5.5' POORLY GRADED MED. SAND, OLIVE GRN, BLACK, MAROON <5-10% FINES, FINE-COARSE SAND, MOSTLY MED, 0% GRAVEL, SATURATED, LOOSE & SLOUGHING.

④ 5.5'-6.4' SANDY GRAVEL, OLIVE GRN, BLACK, MOTTLED. <5% FINES, WELL GRADED SAND TO COARSE GRAVEL, 5-10% COBBLES, SATURATED

GWT @ 5.7' AND RISING SLOWLY @ 11^{30} AM

PHOTO'S ROLL # 1 : #11 : SPOIL PILE LOOKING WEST)
#12 : TRENCH - NOTE THIN TAILS @ SURFACE

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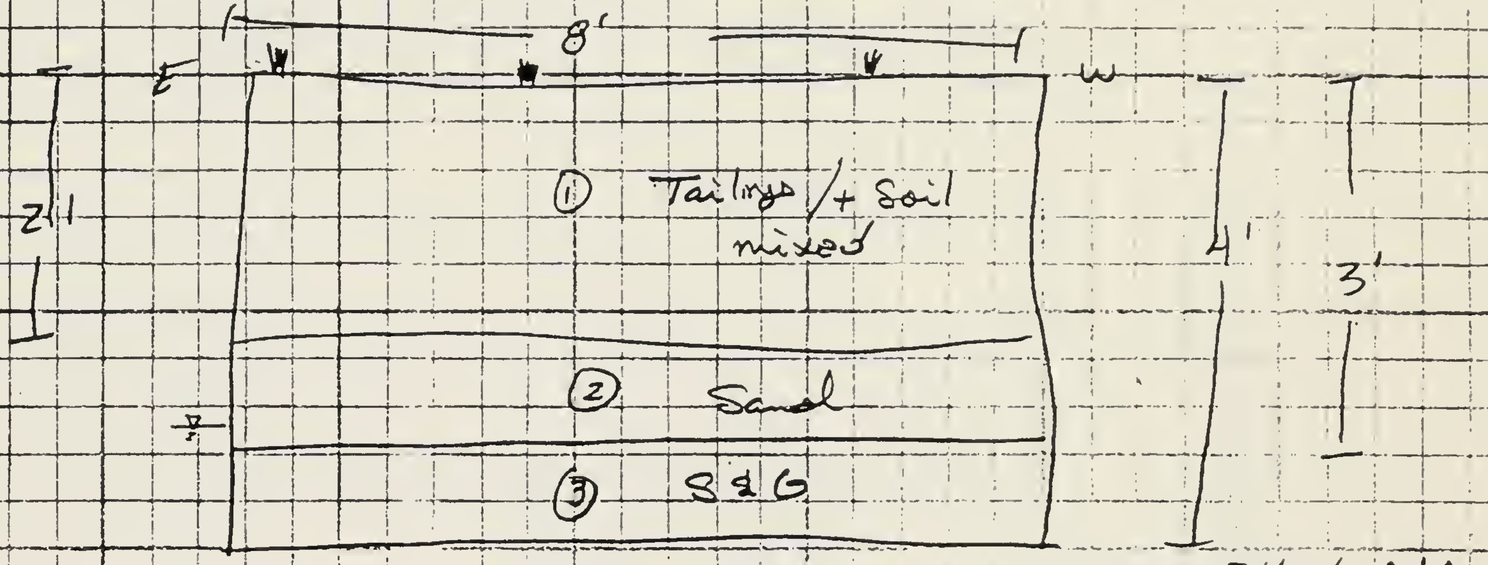
JOB NO. 3381-7A SUBJECT TP-147 Log SHEET NO. 1 OF 1
PROJECT Warm Springs Pond BY AJP DATE 12-18-90

TP-147: SHALLOW DITCH - ~30' S & 50' W. of GW-13
Coordinates: 811304 N, 1172735 E
CASE 580 BACKHOE OPERATED BY J. CLARK

STARTED EX: 11^{45} COMPLETED LOG: 12^{10} pm



Backfilled E/S

① 0'-2.1' INTERBEDDED TOPSOIL & FINE TAILINGS, BLACK TO BROWN-GREEN AND SOME RED STAINING. 60-70% LOW PLAST. FINES, PREDMINANTLY FINE-MED SAND ~30-40%, SOME SPARSE ROOTS, SATURATED

② 2.1'-3' POORLY GRADED MEDIUM SAND OLIVE GRN, BLACK, MAROON. 5-10% FINES, LOW PLAST. POORLY GRADED MED SAND. 0% GRAVEL, SATURATED, LOOSE & SLOUGHING.

③ 3'-4' SANDY GRAVEL, OLIVE GRN TO BLACK, MOTTLED, <5% FINES, WELL GRADED SAND TO COARSE GRAVEL W/ ~5% COBBLES. SATURATED.

GWT @ 2.8' @ 12^{10} PM

PHOTO'S ROLL # 1

13: LOOKING S.E. OVER SPOIL PILE TOWARD POND NO. 1 DIKE

14: UNIT ① CLOSE-UP - MISSING

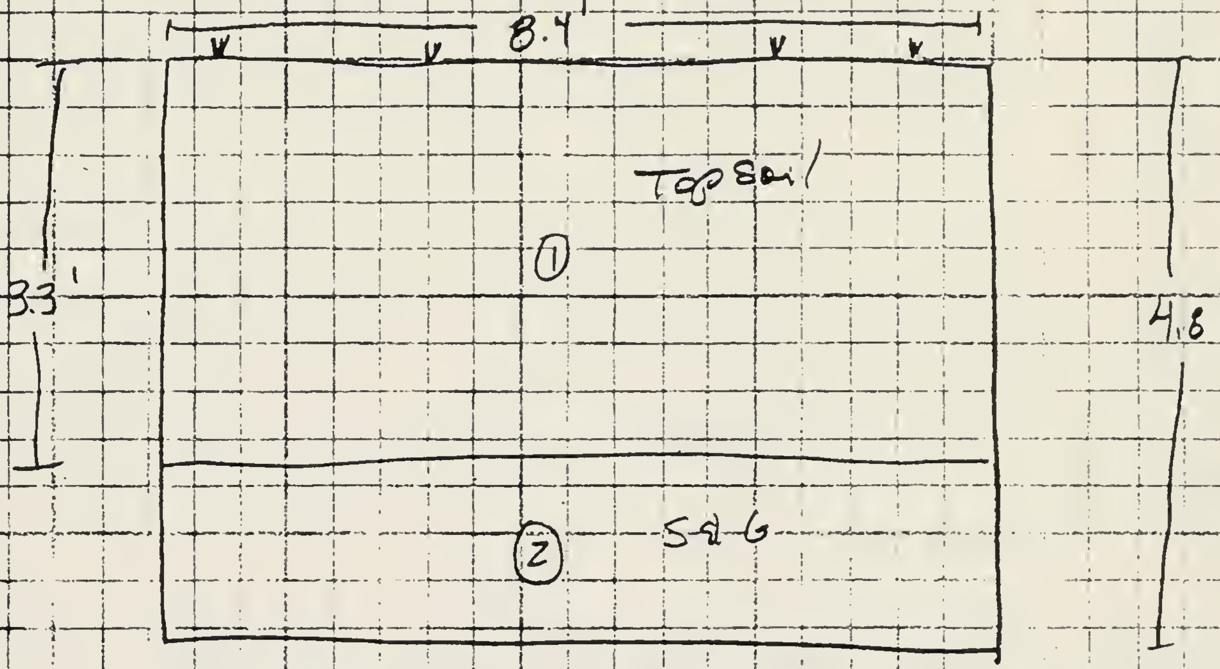
15: LOOKING N, N-W DOWN DITCH.

JOB NO. 3381-7A SUBJECT TP-148 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP-148 : HIGH FLAT GROUND ~ 20' S & 120' W. of GW-13
Coordinates: 811334 N, 1172652 E ±/P
CASE 580C BACKHOE OPERATED BY J. CLARK

STARTED EX: 12^{15} PM COMPLETED LOG: 12^{45} PM



4.3

① 0'-3.3' TOPSOIL, BLACK, 70-80% LOW PLASTICITY FINES, 20-30% FINE-MED SAND. NO GRAVEL. LOOSE, MOIST.

② 3.3'-4.8' SANDY GRAVEL, BUFF TO RED, MOTTLED, <5% FINES, WELL GRADED SAND TO COARSE GRAVEL W/ <5-10% COBBLES. SATURATED.

GWT @ 4.1' AND RISING SLOWLY @ 12^{30} PM

PHOTO'S ROLL # 1

16: VICINITY OF T.P. LOOKING W. TOWARD POND No. 1 DIKE ~~[illegible]~~

17: SPOIL PILE. NOTE RED/ORANGE COLOR OF SANDY GRAVEL.

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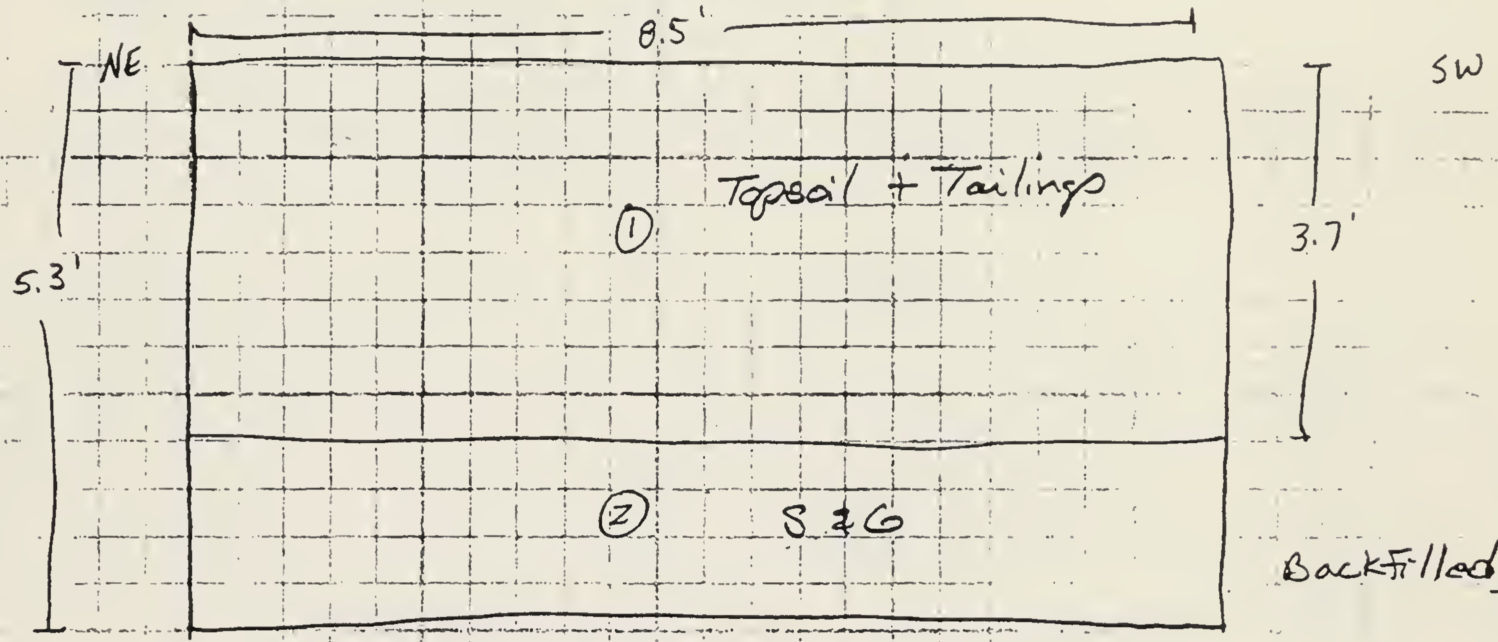
JOB NO. 3381-7A SUBJECT TP-149 SHEET NO. 1 OF 1
PROJECT Warm Springs Ponds - Below Pond 1 BY SJP DATE 12-18-90

TP-149 - 15' N. OF CUT-OFF TRENCH, ~200' S. OF TP-148
Coordinates: 811107N, 1172546E EP
CASE 580C BACKHOE OPERATED BY J. CLARK

STARTED 1^{45} pm, STOPPED 2^{10} Pm



Backfilled EP

① 0'-3.7' TOPSOIL w/ INTERBEDDED TAILINGS (?), BLACK w/ GREEN, YELLOW, DK RED, 70-80% LOW PLASTIC FINES. 20-30% FINE - MED SAND. NO GRAVEL, CONSIDERABLE ROOTS, TAILS VARY FROM GREEN TO YELLOW-RED, FINE GRAINED SLIMES w/ MINOR AMOUNTS OF SAND. MOIST. MED DENSE

② 3.7'-5.3' SANDY GRAVEL, OLIVE GRAY, MAROON, BLACK. <5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL, SM. COBBLES. TOP 6" IS OXIDIZED w/ ORANGE, GREEN, BLUE COLORATION. SATURATED

GWT @ 3.6' @ 2^{05} pm & RISING SLOWLY

SAMPLE: Sm BAG FROM ~2.7'

PHOTO'S ROLL #1

#18: SANDY GRAVEL EXCAVATION
#19: TOPSOIL EXCAVATION - MISSING
#20: VICINITY, LOOKING S.W. TOWARD POND 1 DIKE

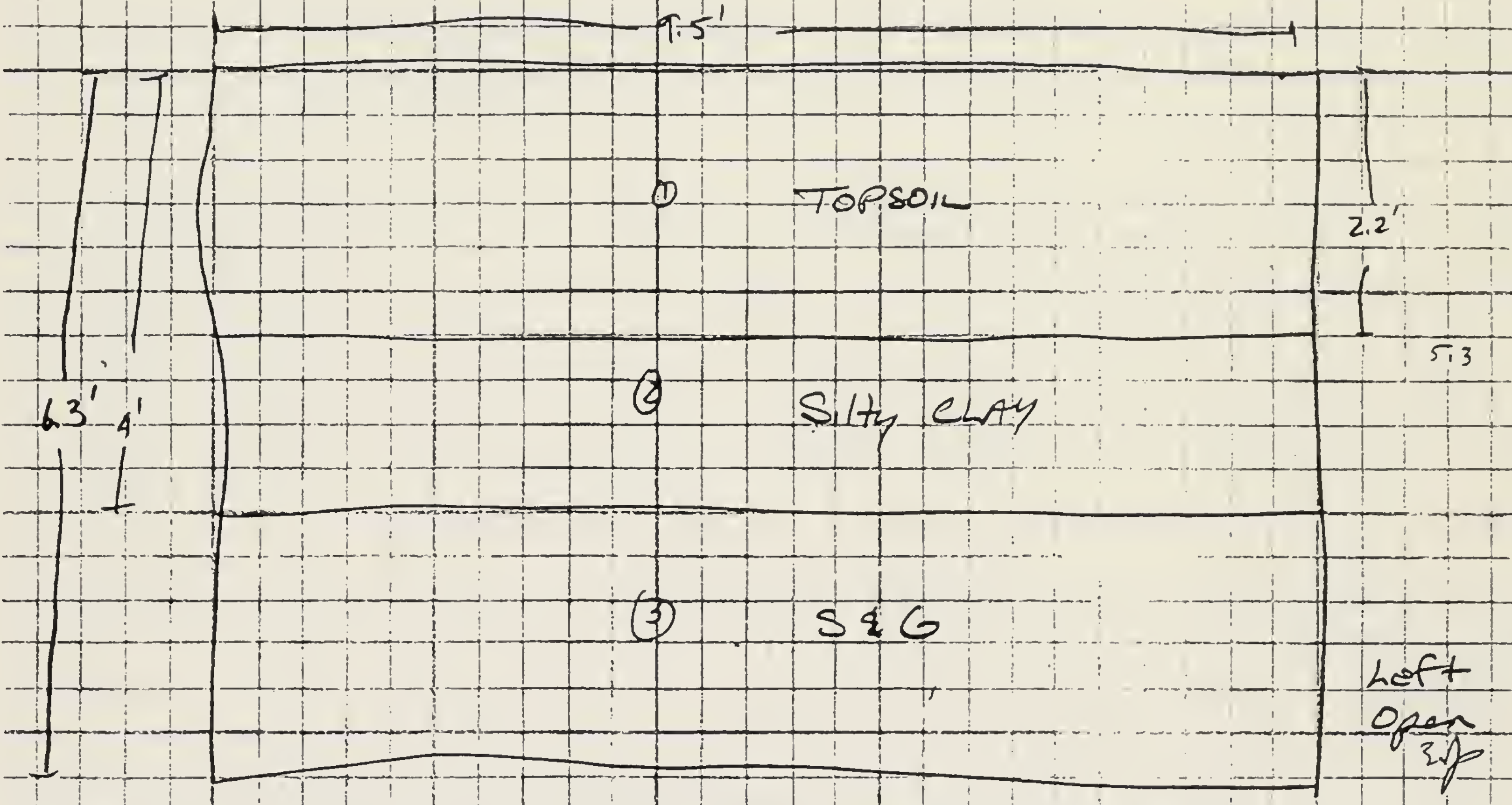
JOB NO. 3381-7A SUBJECT TP-150 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP-150 : 1/2 WAY BETWEEN TP-148 AND TP-149; ~125' NE Pond 1 toe trench
Coordinates: 811213N, 1172596E EJS

CASE 580 C OPERATED BY J. CLARK

STARTED EX: 2^15 pm COMPLETED LOG:



GWT at 3.3' on 1-12-91

① 0'-2.2' TOPSOIL; BLACK, 70-80% FINES, 20-30% FINE-MED SAND. CONSIDERABLE ROOTS TO FULL DEPTH, MOIST

② 2.2'-4' SILTY CLAY, WHITE - BUFF, 70-80% LOW-MOD. PLAST. FINES, 20-30% FINE-MED SAND, NO GRAVEL, MOIST. MAY ONLY BE AN ISOLATED LENSE

③ 4'-6.3' SANDY GRAVEL, OLIVE GREEN, MAROON w/ BLUE GREEN NEAR TOP OF UNIT. <5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL w/ COBBLES. SATURATED.

GWT @ 4.6' @ 2^25 PM ; RISING FAIRLY RAPIDLY

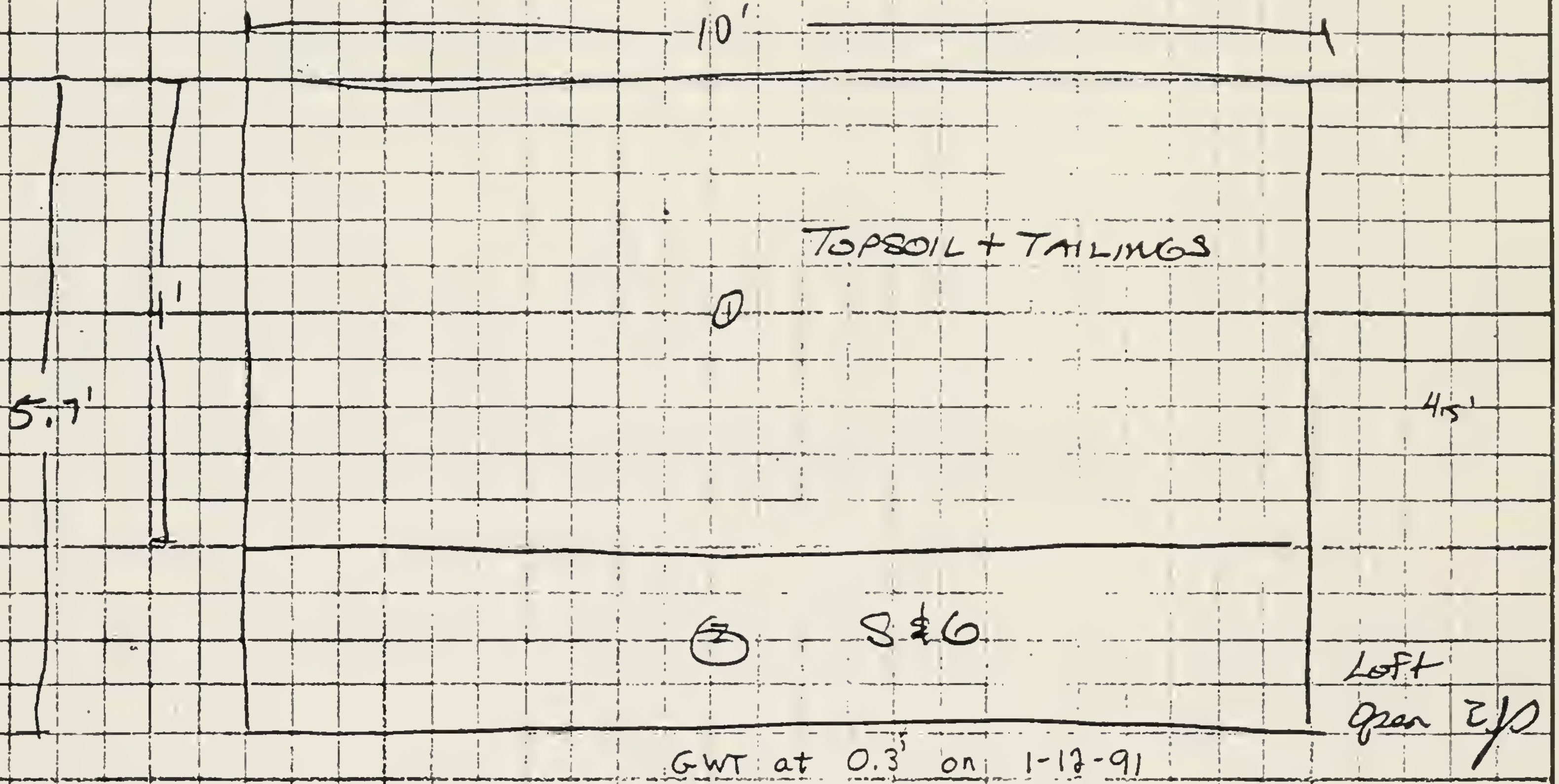
PHOTO'S ROLL #1
21 : CONTAMINATED SANDY GRAVEL IN SPOIL PILE

JOB NO. 3381-7A SUBJECT TP-151 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP 151 - SHALLOW BROAD DITCH, 700' N & 1800' W OF POND 1 SHACK
Coordinates: 811449 N, 1172368 E
CASE 580C BACKHOE OPERATED BY J. CLARK

STARTED EX: 2^35 pm COMPLETED LOG: 3^00 pm



GWT at 0.3' on 1-12-91

① 0'-4' TOPSOIL w/ INTERBEDDED TAILINGS. BLACK w/ OLIVE GREEN & MAROON TAILS. TOP 6" OXIDIZED ORANGE & YELLOW. 60-80% FINES, LOW PLAST. 20-40% FINE-MED SAND. NO GRAVEL. MOIST TO SATURATED.

② 4'-5.7' SANDY GRAVEL, OLIVE GRN, MAROON, BLACK, < 5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL, 5-10% COBBLES, SATURATED.

GWT @ 3.6' @ 2^55 pm

1 sm. BAG : 2'-4'

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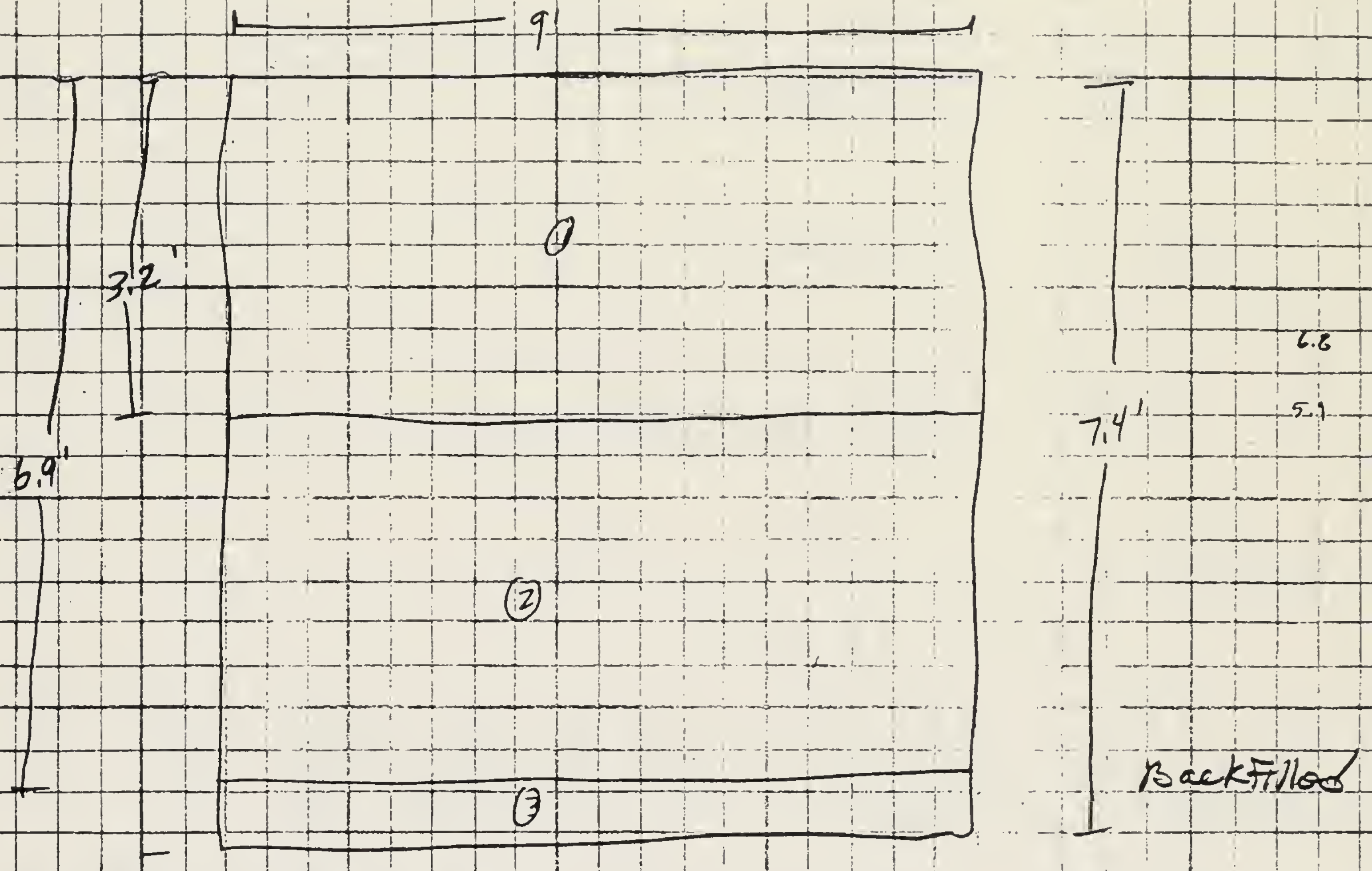
JOB NO. 3381-7A SUBJECT TP-152 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY AJP DATE 12-18-90

TP-152: HIGH AREA NEAR DIKE ACCESS Rd, 1300' N & 1300' W OF POND 1 SHACK
Coordinates: 811793 N, 1172635 E Ep
CASE 580C BACKHOE OPERATED BY J. CLARK.

STARTED Ex: 3^{00} P.m COMPLETED LOG: 3^{40} pm



① 0' - 3.2' TOPSOIL & FILL (?): BLACK, 70-80% FINES, LOW PLAST., 20-30% FINE-MED SAND. SOME ROOTS & ORGANICS FULL DEPTH.

② 3.2'-6.9' SILTY SAND, YELLOW BROWN w/ LENSES OF GREEN-BLUE COLORATION. 15-20% LOW PLAST. FINES, WELL GRADED FINE-COARSE SAND. LENSES OF FINE SAND w/ 40-50% FINES. 0% GRAVEL. MOIST, MOD. DENSE.

③ 6.9' - 7.4' SANDY GRAVEL; OLIVE GRN TO GRAY, MOTTLED. 5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL w/ COBBLES. SATURATED. TOP 2-3" IS UNIFORM MED-COARSE SAND, OLIVE GRN w/ SOME ~~&~~ OXIDIZED YELLOW-ORANGE AT TOP.

GWT @ 5' @ 3^{35} pm

SAMPLED 3.2' - 6.9' Sm BAG.

PHOTO ROLL #1 : 22: SPOIL PILE PHOTO OF SOIL UNIT 3.2' - 6.9'. - MISSING

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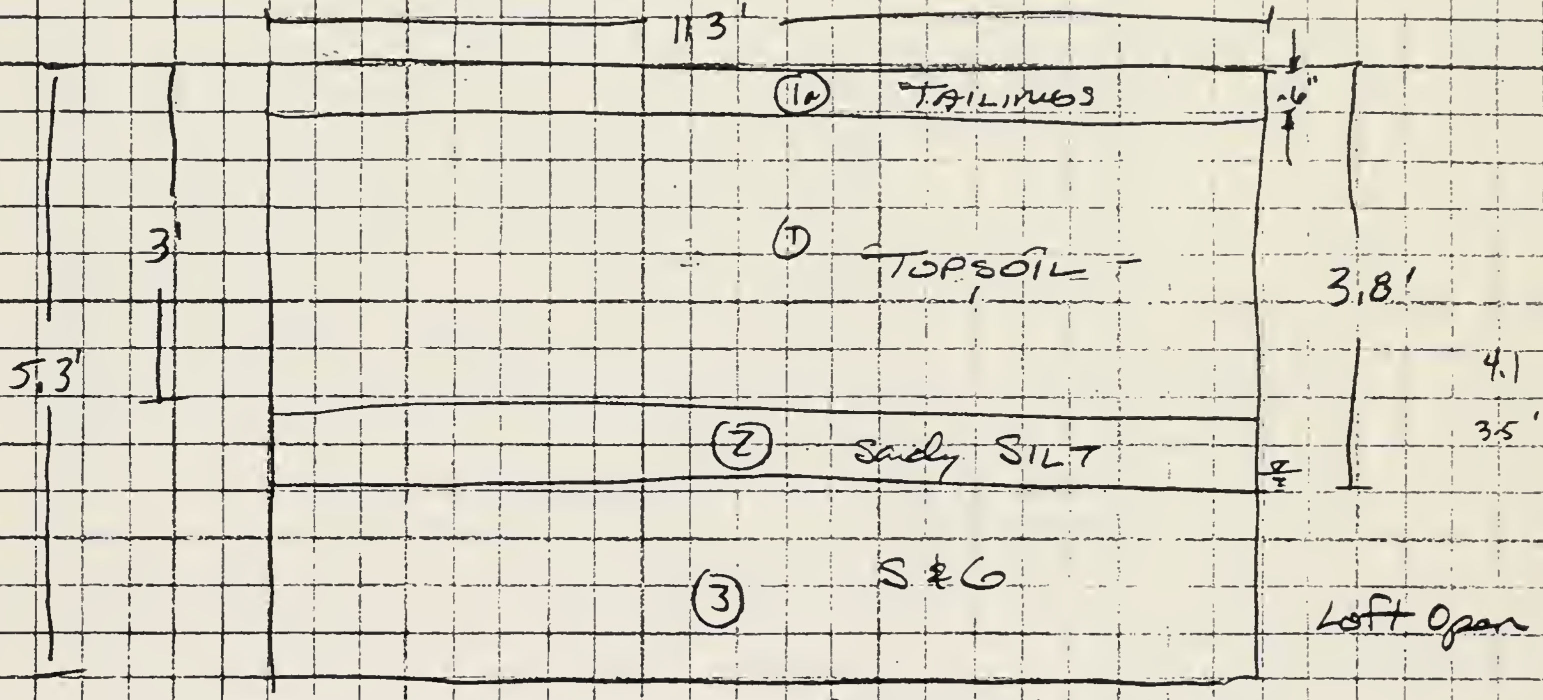
JOB NO. 3381-7A SUBJECT TP-153 SHEET NO. 1 OF 1
PROJECT Warm Springs Ponds - Below Pond 1 BY AJP DATE 12-18-90

T.P. 153 : 60' E. OF SPOIL PILES, 1300' N & 1700' W OF POND 1 SHACK
Coordinates: 812273ON, 1172471E EJD
CASE 580C BACKHOE OPERATED BY J. CLARK

STARTED EX: 3⁵⁵ COMPLETED LOG : 4²⁵ pm



GWT at 0.8' on 1-12-91

① 0'-3' : TOPSOIL, BLACK, 60-70% LOW PLAST. FINES, 20-30% FINE TO COARSE SAND, ~10% GRAVEL & COBBLES. EXTENSIVE ✶ ROOTS FULL DEPTH. MOIST. THIN YELLOW ORANGE TAILS ON SURFACE. (1a)

② 3'-3.8' SANDY SILT, OLIVE GREEN, BLACK, YELLOW. 50-60% LOW-MED PLASTICITY FINES, 20-30% ~~EVENLY~~ GRADED FINE-COARSE SAND, ~10% GRAVEL & SM COBBLES. MOIST-SATURATED, MED. STIFF. SOME ROOTS

③ 3.8'-5.3' SANDY GRAVEL, BLACK-OLIVE GREEN. 5-10% FINES, WELL GRADED SAND TO COARSE GRAVEL & ~5% COBBLES. APPEARS THAT COLORATION BECOMES LESS GREEN W/ DEPTH. SATURATED.

GWT @ 3.5' @ 4¹⁵ pm

PHOTO'S ROLL #1

23 & 24: SPOIL PILE PHOTO OF SOIL 3'-3.8'
25: VICINITY, LOOKING SW TOWARD POND 1 DIKE.

1 SM BAG SAMPLE, 3'-3.8'

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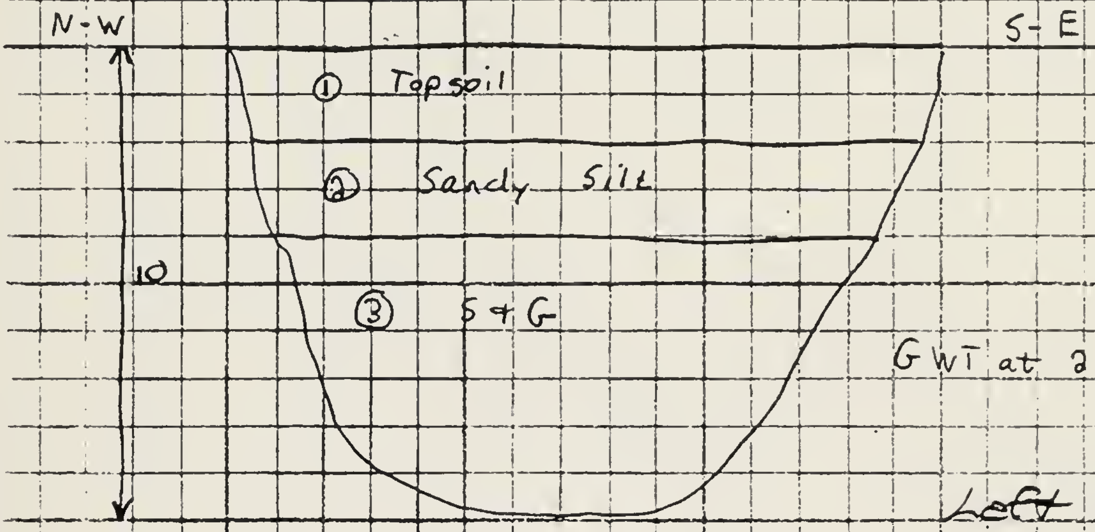
JOB NO. 3381-7A SUBJECT TP-154 SHEET NO. 1 OF 1

PROJECT WSP BY Jt DATE 1-9-91

TP-154 Location: 580' S-E of TP-183 + 50' From water
Coordinates: 811862N, 1171820E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1535 Finish: 1545
Photo: None



GWT at 2.9' on 1-12-91

~~Left~~ Open

① 0-2' TOPSOIL: Dark Brown to black, Top 6" Frozen root zone

② 2-4' SILT: Grayish White; 5-10% Fine sand; Plastic, sticky, runny in some places saturated, calcareous

③ 4-10' SAND + GRAVEL: Light green to Gray; 20% Fines; becomes coarser, denser, darker in color + cleaner w depth; sides keep slussing, some iron stained Lenses; saturated

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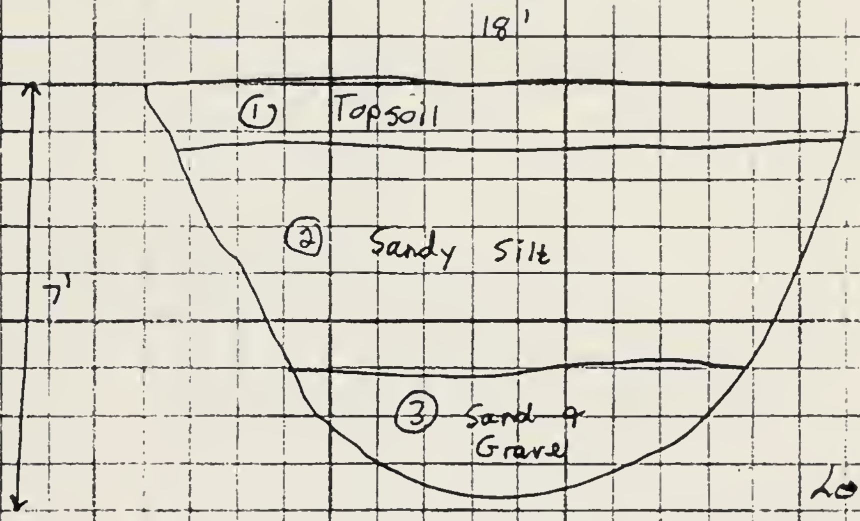
JOB NO. 3381-7A SUBJECT TP-166 SHEET NO. 1 OF 1
PROJECT Warm Springs Ponds BY JAC DATE 1-8-91

TP-166 Location: 360'N + 150' E of NW Corner of Pond 1
Coordinates: 813243N, 1170655E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1350 Finish: 1410
Photo: Roll # 8 Frame 32



GWT at 3.0' on 1-12-91

Left Open

① 0-0.7' TOPSOIL: Sandy silt Brown to Light Brown; Top 3": Frozen root zone

② 0.7'-5.3' SANDY SILT: Dark Brown on top & transforms to Light gray with depth; < 5% Fine sand; Soil gets wetter with depth, sluffs; slightly plastic
- Sample taken

③ 5.3-7' SAND + GRAVEL: Black to Dark Brown, green mottling; Clean sand, 40%; occasional cobbles up to 4" Fairly dense, Sluffing

Sample: 1 small bag, 4.0-5.0'

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JOB NO. 3381-7A SUBJECT TP - 167 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY Jte DATE 1-8-91

TP-167

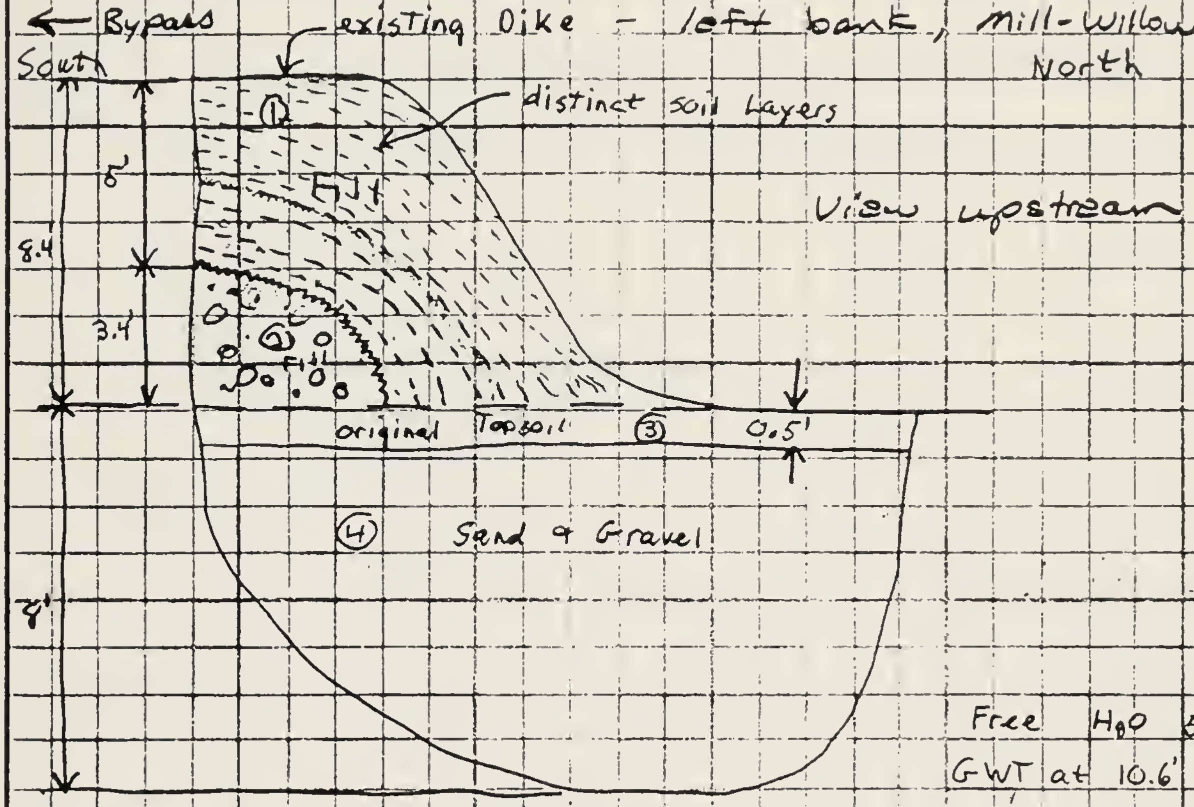
Location: 400'N + 770' E of NW corner Pond 1

Coordinates: 813258N, 117 1174 E

Contractor: JCI Machine: 690 Excavator Operater: Rich Orhen

Start: 1415 Finish: 1435

Photos: Roll # 18 Frames 33 + 34 (Facing South)



Free H_2O 5' Below Topsoil

GWT at 10.6' Below Top of Dike on 1-17-91

① 0-5' FILL: Light Brown silty sand

② 5-8.4' SAND + GRAVEL FILL: Light Brown; 20% Fines, 30% Sand + 50% gravel; Fairly dry

③ 8.4-8.9' TopSOIL: Black Sandy Silt, Some organics with slight odor; Moist turns Lighter gray w/ depth + becomes siltier + more plastic

④ 8.9'-16.9' SAND + GRAVEL: Light green clean sand, 50%; Clean gravel, 50%; Saturated; Becomes denser with depth; Iron staining

Samples: 1 small bag TP-167-1 2.5'-3' below Top soil

JOB NO. 3381-7A SUBJECT TP-168 SHEET NO. 1 OF 1

PROJECT Warm Springs Ponds BY Jtc DATE 1-8-91

TP-168

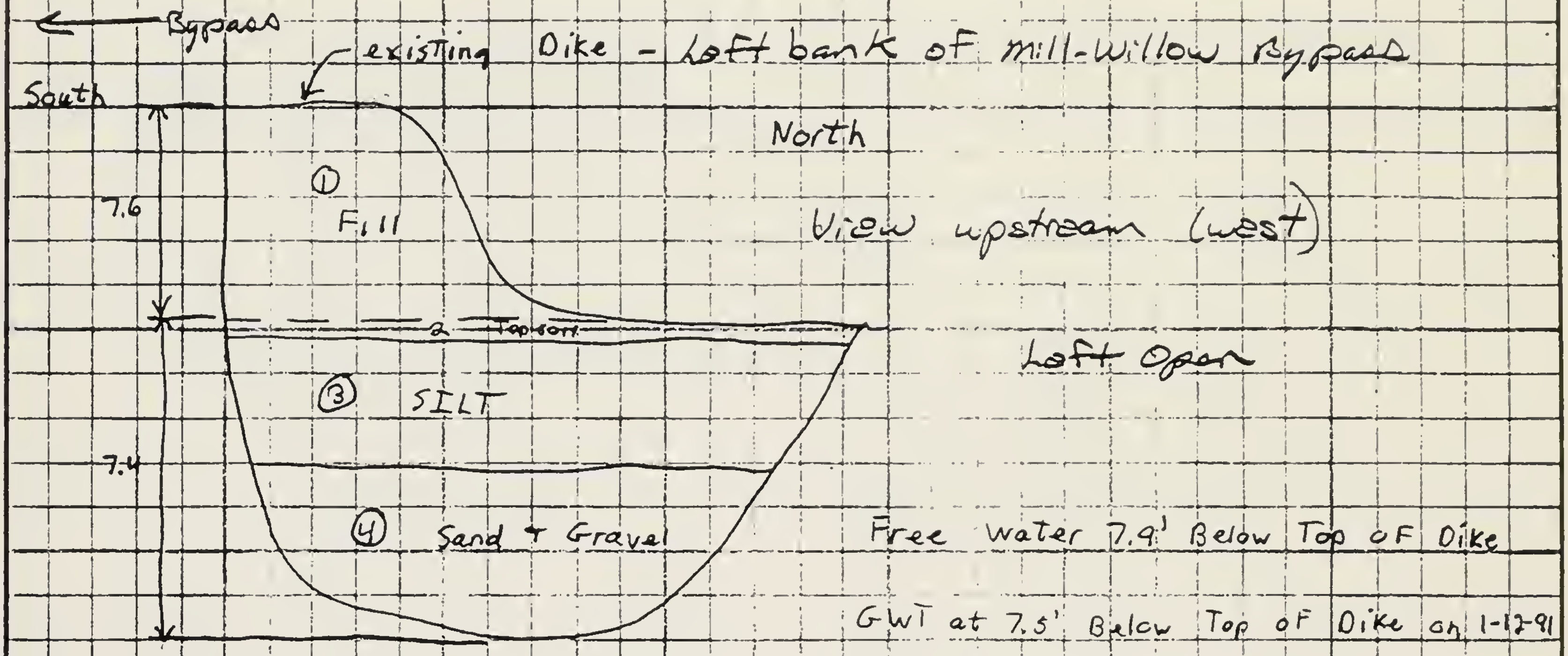
Location: 470' N & 1330' E

Coordinates: 813350N, 1171658E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1445 Finish: 1505

Photos: Roll #18 Frames: 35, 36 & possibly 37 (end of roll)



Free water 7.9' Below Top of Dike

GWT at 7.5' Below Top of Dike on 1-12-91

① 0-7.6 FILL: Sandy Silt Light brown with Tan mottling; Top 6" Frozen Moist

② 7.6'-7.8' TOPSOIL: original Black Topsoil; very organic with strong odor; Very wet to saturated, Plastic

③ 7.8'-10.8' SILT: Light Gray; < 5% Fine sand, Plastic, Very wet Sample Taken

④ 10.8-15' SAND & GRAVEL: Light green to Dark green, some Iron stained, 20% gravel, traces of silt, Sluffs occasional cobbles up to 5"

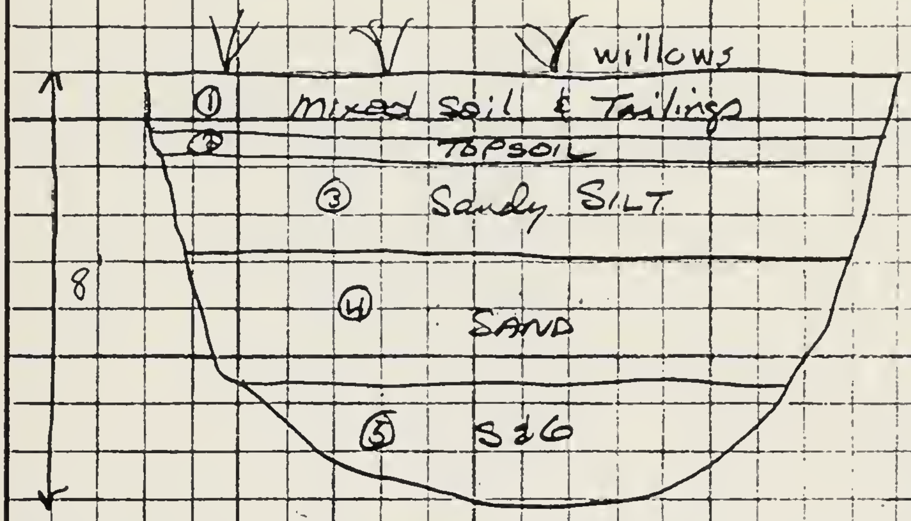
Samples: 1 small Bag TP-168-1 8.0-8.5'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-169 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY Jk DATE 1-8-91

TP-169 Location: 470' East of TP-168 & 50' North of Mill-Willow Bypass
Coordinates: 813469N, 1172288E EJO
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1520 Finish: 1540
Photo: Roll #19 Frame: 1 w̄ Flash, 2 & 3



Free water at 4.8'

GWT at 2.3' on 1-12-91

Left Open

① 0-2' MIXED SOIL + TAILINGS: Light Brown & Tan

② 2.0-2.2' TOPSOIL: Black, Fine silty sand, Micaceous, Roots & other organics
Saturated

③ 2.2'-4.8' SANDY SILT: Black & turns Gray with depth, Plastic, Micaceous, some organics; becomes sandier w̄ depth; saturated

④ 4.8'-6.0 SAND: Lt green to Lt brown, Fine to Med clean sand; Loose, readily caves; iron stained Lenses, sluffs; saturated

⑤ 6.0-8.0 SAND & GRAVEL: Lt green to Gray; Few 4" cobbles
Too much water to describe

Sample: 1 small bag, TP-169-1 3-3.5'
1 small bag, TP-169-2 5-5.5' EJO

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-170 SHEET NO. 1 OF 1

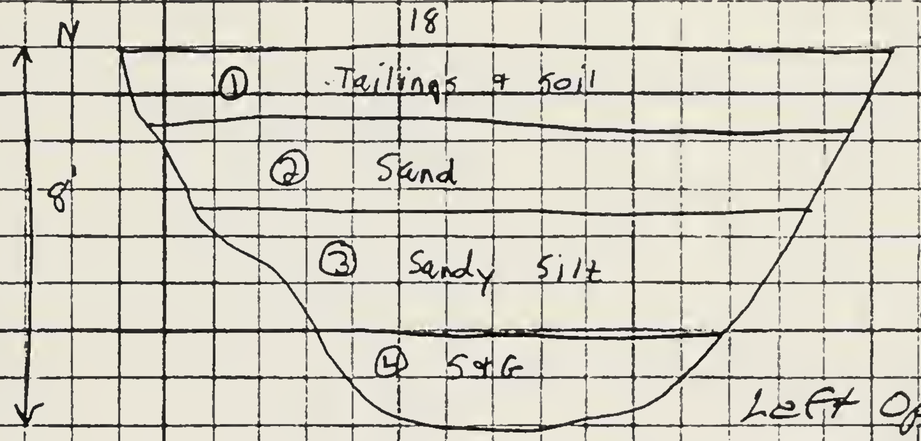
PROJECT WSP Below Pond 1 BY Jtc DATE 1-8-91

TP-170

Location: 350' N-E of TP-169 + 100' From lower Silver Bow Creek
Coordinates: 813645N, 1172601E Efa

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1545 Finish: 1555
Photo: Roll 19 Frame H



Free H_2O at 5.6'

GWT at 4.0' on 1-12-91

Left Open

① 0-3.5' TAILINGS: Browns + Greens; some copper stained Lenses

② 3.5-4.2 SAND: Lt green, med clean sand, ~5% Mica; wet

③ 4.2-5.6 SANDY SILT: Black + DK brown; <5% Fine sand, plastic, sticky
roots + other organics

④ 5.6-8.0 SAND + GRAVEL: Black to DK Gray, Med grained sand; some
cobbles up to 6", sluffs; saturated

JOB NO. 3381-7A SUBJECT TP-171 SHEET NO. 1 OF 1

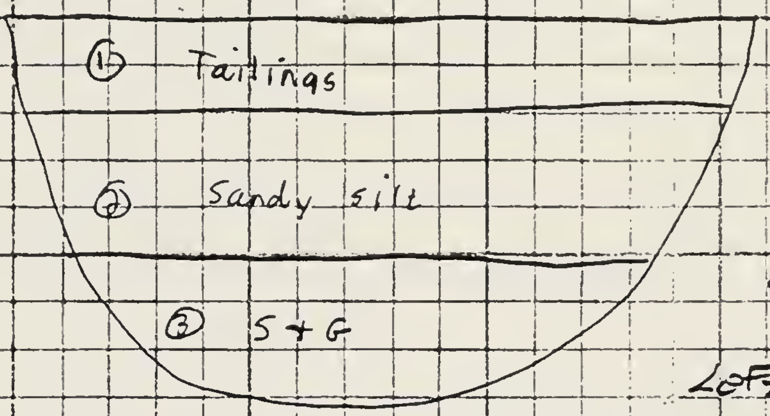
PROJECT WSP Below Pond 1 BY Jtc DATE 1-8-91

TP-171 Location: 300' N-W of TP-170 + 50' From lower Silver Bow Creek
Coordinates: 813467N, 1172236E E/P

Contractor: JCI Machine: 690 Excavator Operator: Rich Orchen

Start: 1600 Finish: 1620
Photo: Roll 19 Frame 5

Machine operated For 8 hours on 1-8-91. Total of 12 hours to date



Free H_2O at 5.5'

GWT at 3.0' on 1-17-91

Left Open

① 0-2.2' MIXED SOILS + TAILINGS: Brown + Tan on Top, turns Dk brown + red with depth; Fine sand + gets coarser w̄ depth; some roots

② 2.5-5.5 SANDY SILT: Dk green to Black; very Fine sand; Micaceous, some organics; slightly Plastic; color darkens w̄ depth; saturated

③ 5.5'-8' SAND + GRAVEL: Dk Brown to Black; Med to coarse clean sand; readily sluffs; Gravel up to 2", very Few cobbles, saturated

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JOB NO. 3381 - 7A SUBJECT TP- 172 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-9-91

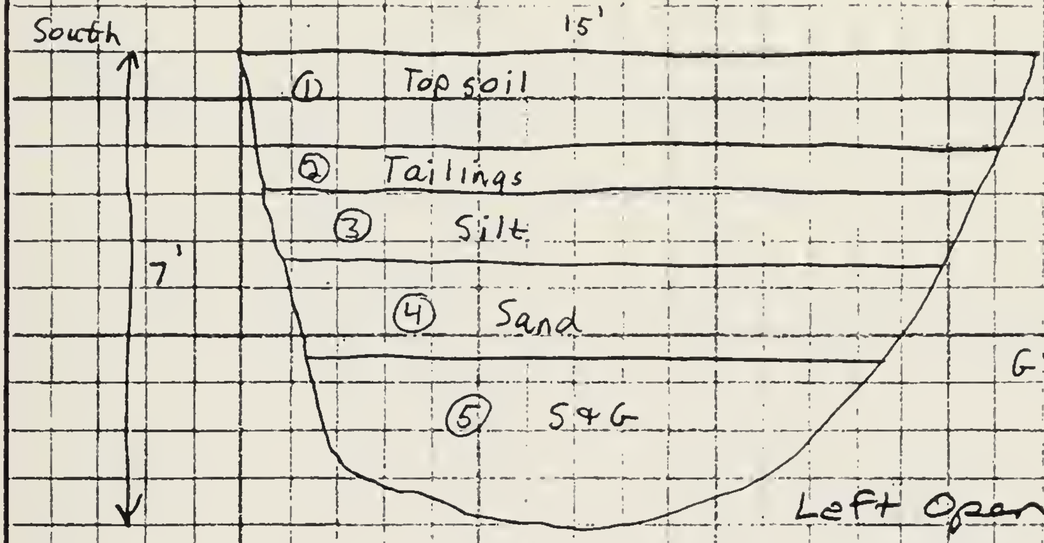
TP-172 Location: 250' West of TP-171 & 150' S-W of lower Silver Bow Ck.

Coordinates: 813546N, 1171977E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0845 Finish: 0905

Photo: Roll 19 Frame 6



Free H_2O at 2'

GWT at 1.2' on 1-12-91

① 0-2' TOPSOIL: Black; Highly organic w̄ ador, roots, Top 1' Frozen

② 2-2.4' TAILINGS: Lt. Brn, yellow & reds, Fine grained, slightly Plastic, Saturated

③ 2.4-3.0' SILT: Dk Gray to Black, < 5% Fine sand, plastic; Highly organic w̄ ador; saturated

④ 3.0-4.5' SAND: Dk green to Black, Fine to Med grained, < 10% Fines; some organics, Loose & sluffing, coarsens w̄ depth; saturated

⑤ 4.5-7' SAND & GRAVEL: Dk green to Black; very clean; 60% Sand, SP; 30% Gravel; up to 4" cobbles, saturated

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JOB NO. 3381- 7A SUBJECT TP- 173 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-9-91

TP- 173

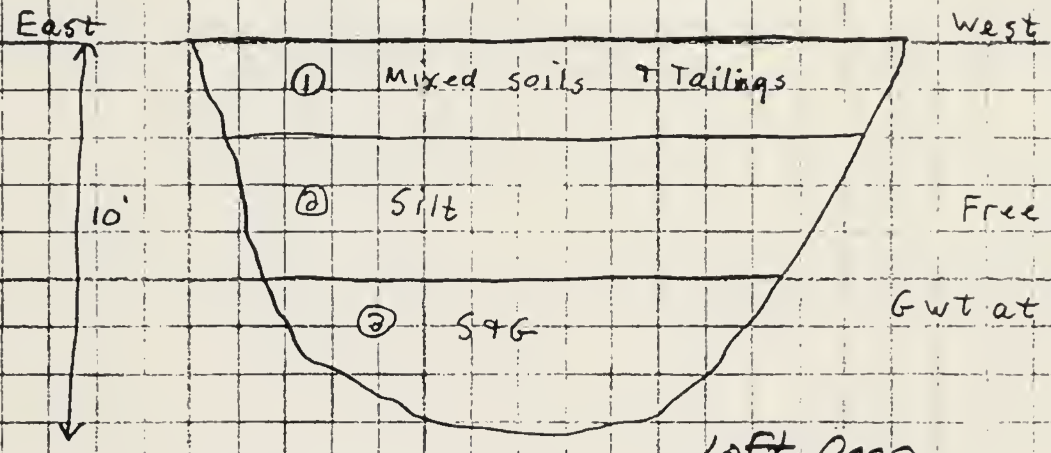
Location: 250' N of TP-172 + 50' W of lower Silver Bow Creek

Coordinates: 813880N, 1172008E Zp

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0915 Finish 0930

Photo: Roll 19 Frames 7 + 8 Taken in a vertical series



Free H_2O at 7'

Gwt at 5.0' on 1-12-91

Left Open

① 0-3' MIXED SOILS + TAILINGS; interbedded reds, tans + yellows; some iron stained very fine sand; some organics, Top 6" Frozen some black silt lenses

② 3'-7' SILT: DK Gray to Black; 5-10% Fine sand, highly organic + color darkens w̄ depth; Moist to wet

③ 7'-10' SAND + GRAVEL: Lt green to DK Gray; 50% Med to Coarse sand; Fairly dense, very clean, becomes coarser w̄ depth, sluFFs; up to 6" cobbles, saturated

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JOB NO. 3381-7A SUBJECT TP-174 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-9-91

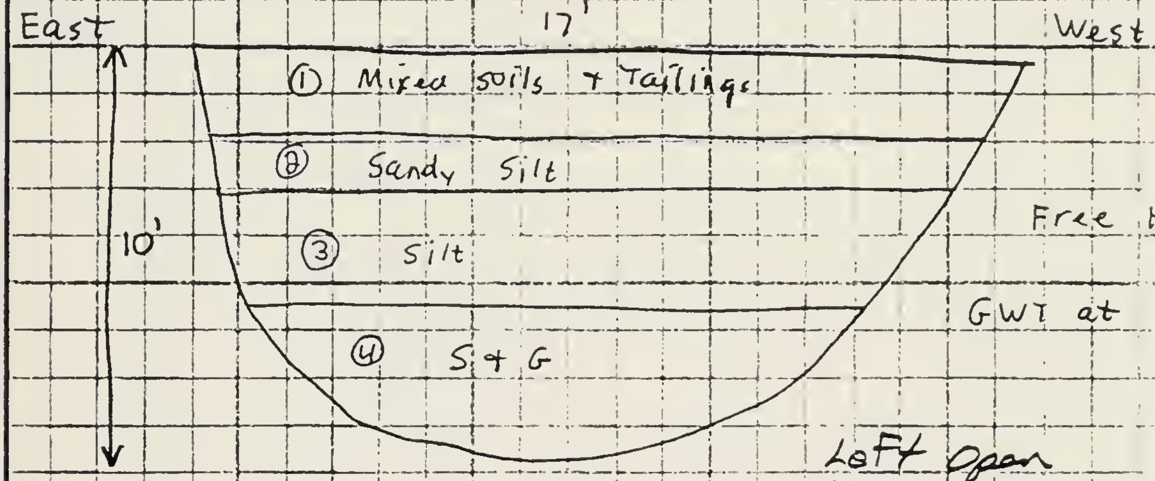
TP-174 Location: 340' N-W of TP-173 & 80' W of lower Silver Bow Creek

Coordinates: 814193N, 1171815E EJD

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0935 Finish: 0950

Photo: Roll 19 Frame 9



Free H_2O at 7'

GWT at 4.0 on 1-12-91

Left Open

① 0-2.8' MIXED SOILS & TAILINGS: whites, browns, tans & reds; Top 1.6' Frozen
Iron stained

② 2.8-3.8' SANDY SILT: Lt green clean Fine sand Lenses, black silt Lenses
Some organics; Moist

③ 3.8-7.0' SILT: Black; some organics & small roots w̄ organic odor;
Plastic; Saturated

④ 7-10' SAND & GRAVEL: Black; Fairly Dense; Gets cleaner & coarser
w̄ depth 60% gravel; up to 6" cobbles; Saturated

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JOB NO. 3381-7A SUBJECT TP-175 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-9-91

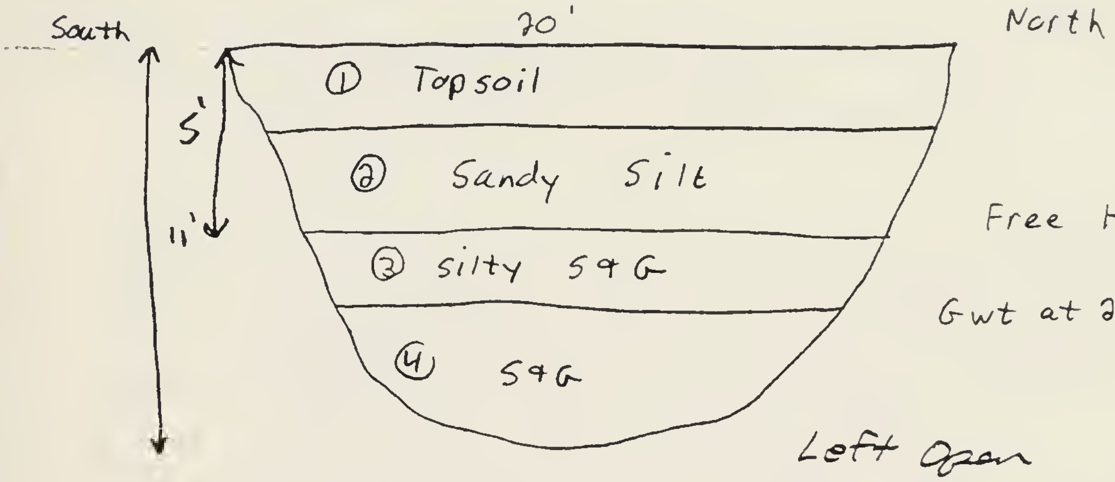
TP-175 Location: 230' N-W of TP-174 + 80' S-W of lower Silver Bow CK.

Coordinates: 814257N, 1171582E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0955 Finish: 1005

Photo: Roll 19 Frame 10



Free H_2O at 5'

Gwt at 2.5' on 1-12-91

Left Open

① 0-2' TOPSOIL: Black on top + get Lighter color w̄ depth; sandy silt
6" Frozen root zone

② 2'-5' SANDY SILT: white to very Lt Brown, Plastic + sticky, water seepage in a Few places, some organics; sluffs; up to 4" cobbles, saturated

③ 5'-8.5' SILTY SAND + GRAVEL: Black to DK Brown, slightly plastic, 20-30% Fines
Saturated

④ 8.5'-11' SAND + GRAVEL: Tan to Light Brown + Black; Fairly clean, Loose; Too much water to describe Further

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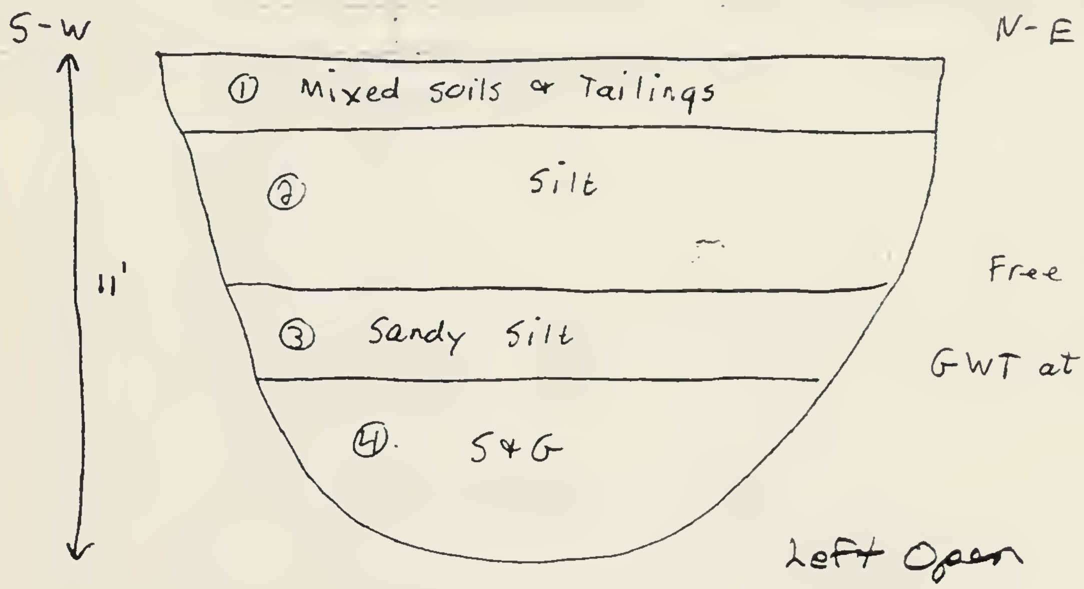
JOB NO. 3381-7A SUBJECT TP-176 SHEET NO. 1 OF 1
PROJECT WSP Below Pond I BY Jtc DATE 1-9-91

TP-176 Location: 360' S-E of TP-175 & 75' N of gas Line; ~200' W of
Coordinates: 813953N, 1171720E lower Silver Bow Ck
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1010 Finish: 1030
Photo: Roll 19 Frame 11



Free H_2O at 5.0'

GWT at 2.0' on 1-12-91

Left Open

① 0-1.2' MIXED SOILS & TAILINGS: Tan & red; Top 0.8' Frozen

② 1.2-5' SILT: Grayish white, <5% Fine grained Sand; Plastic and sticky, some organics, sluffs, Saturated & calcareous

③ 5-6.3' SANDY SILT: Black; <5% Fine grained sand; some organics w̄ odor Micaceous; Wet; some gravels

④ 6.3-11 SAND & GRAVEL: Reddish Browns & Lt greens to gray; 20% Fines becomes coarser, denser, darker in color, & cleaner w̄ depth; sides keep sluffing, some iron stained Lenses; saturated

Sample: 1 small bag, TP-176-1 2.5-3.0'

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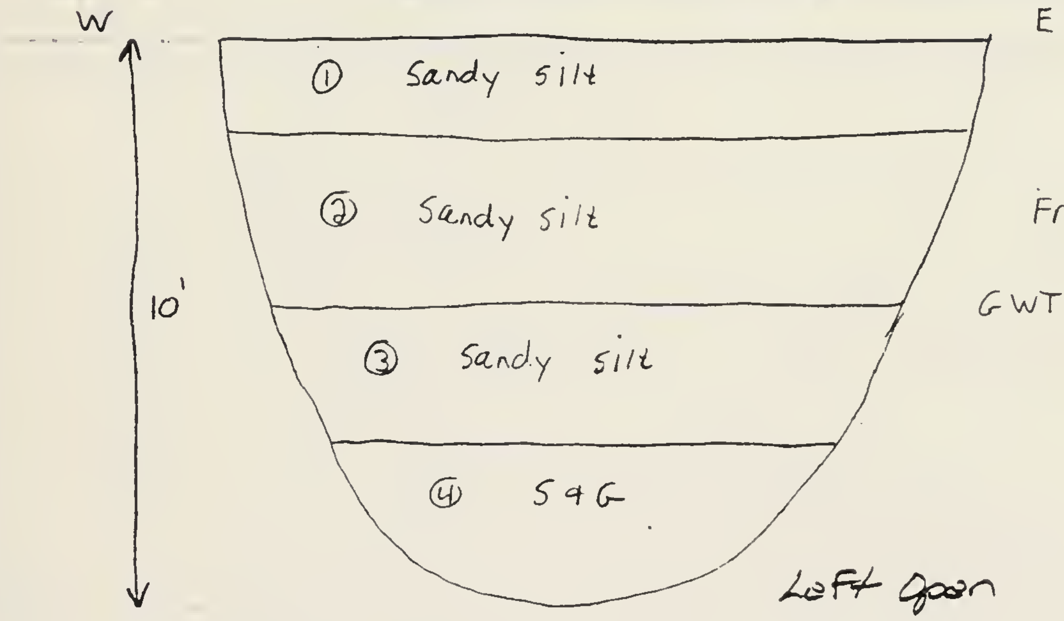
JOB NO. 3381-7A SUBJECT TP-177 SHEET NO. 1 OF 1
PROJECT WSP BY DATE 1-9-91

TP-177 Location: 200' W of TP-177 & 75' N of gas Line
Coordinates: 813 876N, 1171547E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orken

Start: 1033 Finish: 1040
Photo: Roll 19 Frame 12

~375' west of lower Silver Bow Creek



Free H_2O at 6'

GWT at 3.0' on 1-12-91

Left Open

① 0-2.2' SANDY SILT: Light Brown to Tan, Low density, ROOTS, Slightly Plastic, Moist

② 2.2-6' SANDY SILT: Grayish White, <5% Fine sand; Plastic & sticky, some organics, sluffs, saturated; Some gravel pockets From 4' to 6'

③ 6'-7.5' SANDY SILT: Light Brown, Plastic, 5-10% Fine sand, saturated

④ 7.5'-10' SAND & GRAVEL: DK Gray to Black; 10-20% Fines, 20-30% Sand; Fairly Dense; sluFFS; saturated

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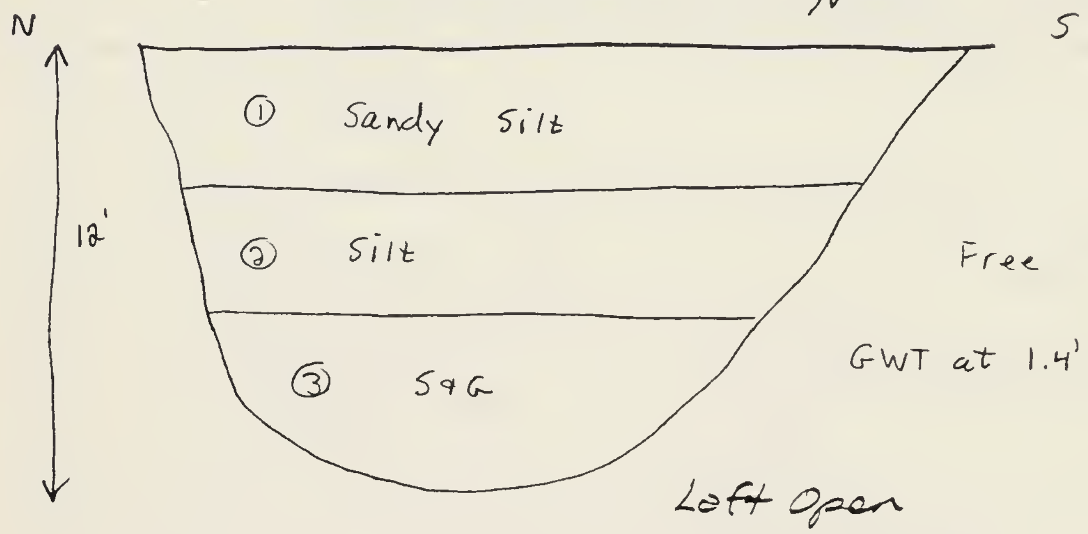
JOB NO. 3381-7A SUBJECT TP-178 SHEET NO. 1 OF 1
PROJECT WSP BY Jtc DATE 1-9-91

TP-178 Location: 300' SW of TP-177 & 180' N of TP-168
Coordinates: 813585N, 1171596E EJB
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1045 Finish: 1100
Photo: Roll 19 Frame 13

200' North of M-W Bypass



Free H_2O at 4'

GWT at 1.4' on 1-12-91

Left Open

① 0-4' SANDY SILT: Lt Gray to Brown; 6" root zone, some organics, Plastic, sluffs, saturated

② 4'-6' SILT: Black & Brown; Some sand & gravel Pockets w̄ 20-30% Fines; Med grained sand, gets cleaner w̄ depth, saturated

③ 6-12' SAND & GRAVEL: Dull Brown & Dark green & gray; 30% Fines, 70% sand & gravel; Fairly dense, material becomes coarser w̄ depth, saturated

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JOB NO. 3381-7A SUBJECT TP-179 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-9-91

TP-179 Location: 430' W of TP-178 + 200' N of TP-167

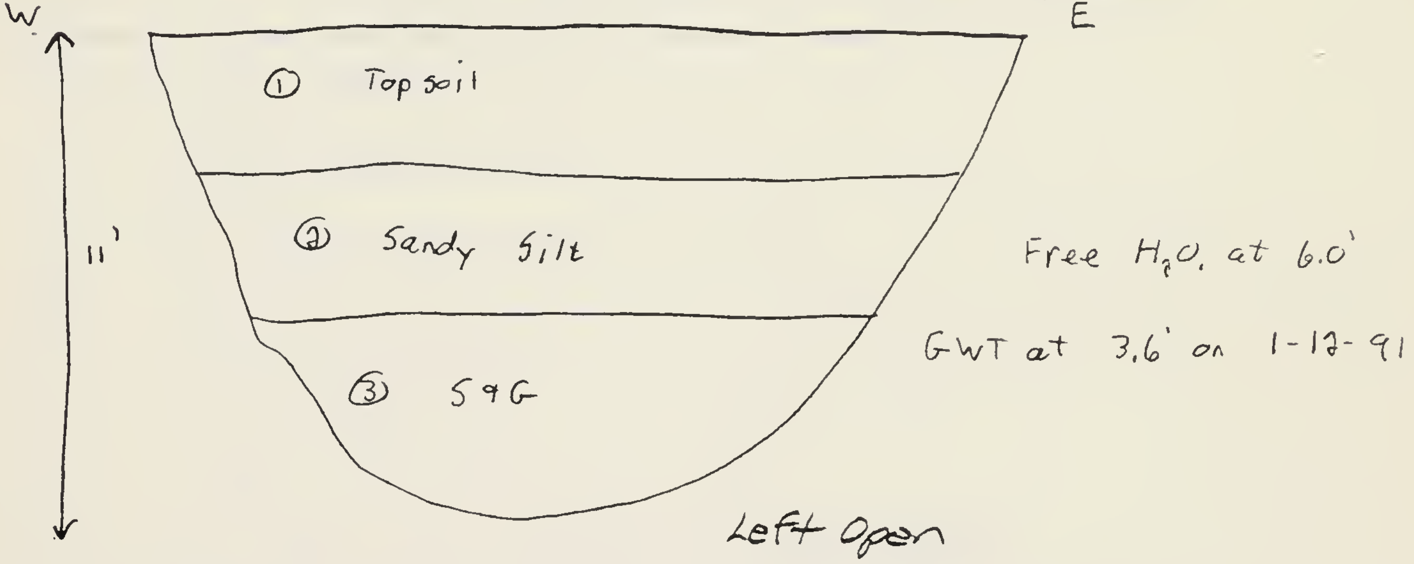
~~Coordinates~~: 813479N, 1171074E ejp

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1105 Finish: 1115

Photo: Roll 19 Frame 14

100' North of Mill-Willow Bypass



Free H_2O at 6.0'

GWT at 3.6' on 1-12-91

Left Open

① 0-2.0' TOPSOIL: Blacks + Browns; sandy silt, <5% sand; 6" root zone; some organics; Plastic; Wet

② 2.0-4.5' SANDY SILT: Same as TP-176 From 1.2-5'

③ 4.5-11' SAND + GRAVEL: Light Green w̄ Brown mottling; 30% Fines; becomes Cleaner + denser w̄ depth, sluffs; up to 5" cobbles; saturated

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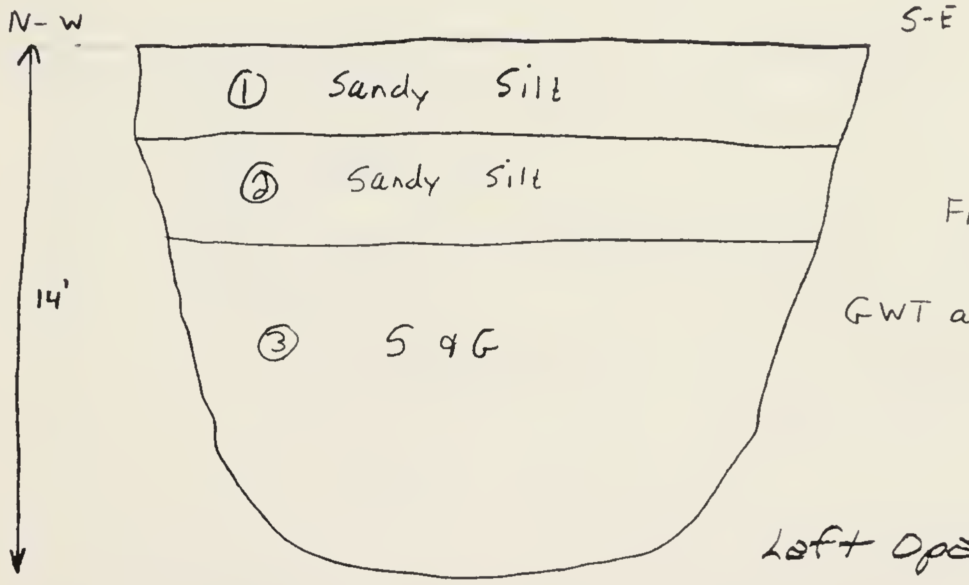
JOB NO. 3381- 7A SUBJECT TP-182 SHEET NO. 1 OF 1
PROJECT WSP BY Jk DATE 1-9-91

TP-182 Location: 300' S-E of GW03 & 100' N-E of Bnd 1 toe trench
Coordinates: 812464N, 1171243E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1505 Finish: 1520
Photo: None



Free H_2O at 3.5'

GWT at 2.9' on 1-12-91

Left Open

① 0-1.2' SANDY SILT: Dark Brown to Black; slightly Plastic, roots & other organics; Moist

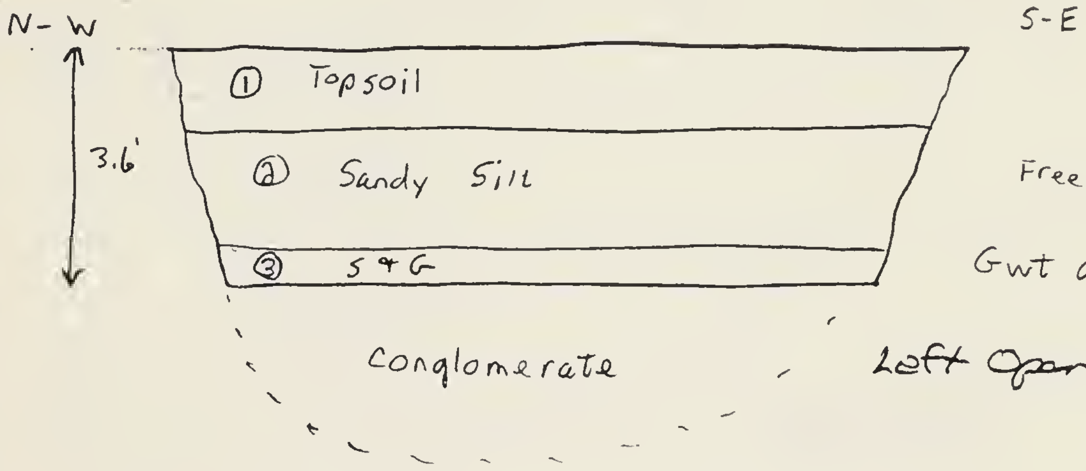
② 1.2- 3.5' SANDY SILT: Grayish Black; 10% Fine sand; Calcareous, Plastic.

③ 3.5 - 14' SAND & GRAVEL: Lt green, gray & dark yellow, slight iron stained; 20% Fines 60% Fine to Med Sand; becomes coarser & cleaner w/ depth, sluffs, up to 6" cobbles, saturated

JOB NO. 3381-7A SUBJECT TP-183 SHEET NO. 1 OF 1
PROJECT WSP BY Jtc DATE 1-9-91

TP-183 Location: 350' S-E of TP-182, 100' NE of Pond 1 toe trench
Coordinates: 812205N, 1171547E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1525 Finish: 1530
Photo: None



Free H_2O at 2.8'

Gwt at 2.0' on 1-17-91

Left Open

① 0-1.2 TOPSOIL: Light Brown to Gray, silty sand, some organics
MOIST

② 1.3-3' SANDY SILT: Light Gray to white, 20% Fine sand, calcareous, wet

③ 3'-3.6' SAND & GRAVEL: Lt green to Dark Brown; Dense; 20% Fines; Saturated

at 3.6' we had refusal, the conglomerate was too hard

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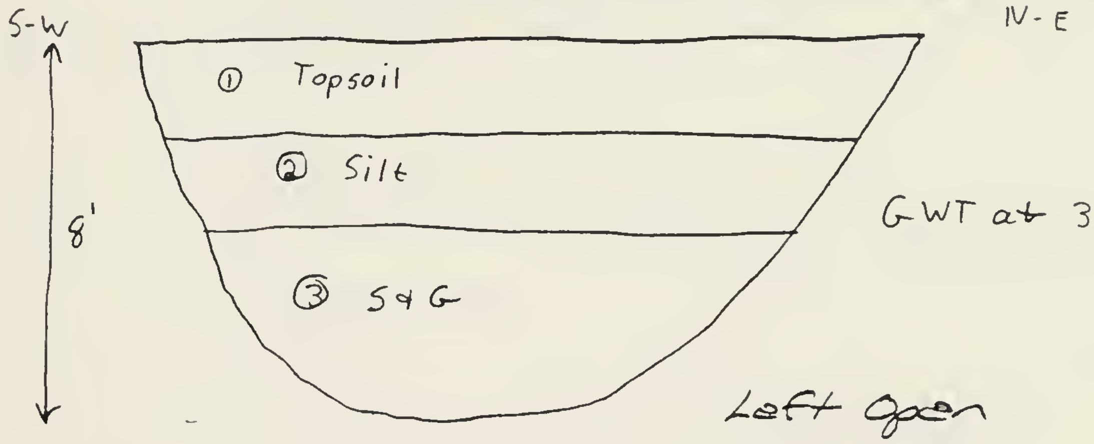
JOB NO. 3381-7A SUBJECT TP-184 SHEET NO. 1 OF 1
PROJECT WSP BY Jtc DATE 1-9-91

TP-184 Location: 270' N-E of TP-154 + 100' W of drain from Pond 1
Coordinates: 811903N, 1172112E EJS
contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1545 Finish: 1555
Photo: None

250' NE of Pond 1 toe trench EJS



GWT at 3.0' on 1-12-91

Left Open

① 0-2' TOPSOIL: DK Brown Sandy Silt; Top 6" Frozen

② 2-4' SILT: Same as TP-176 From 1.2-5'

③ 4-8' SAND + GRAVEL: Same as TP-176 From 6.3-11'; up to 6" cobbles

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JOB NO. 3381-7A SUBJECT TP-185 SHEET NO. 1 OF 1
PROJECT WSP BY DATE 1-9-91

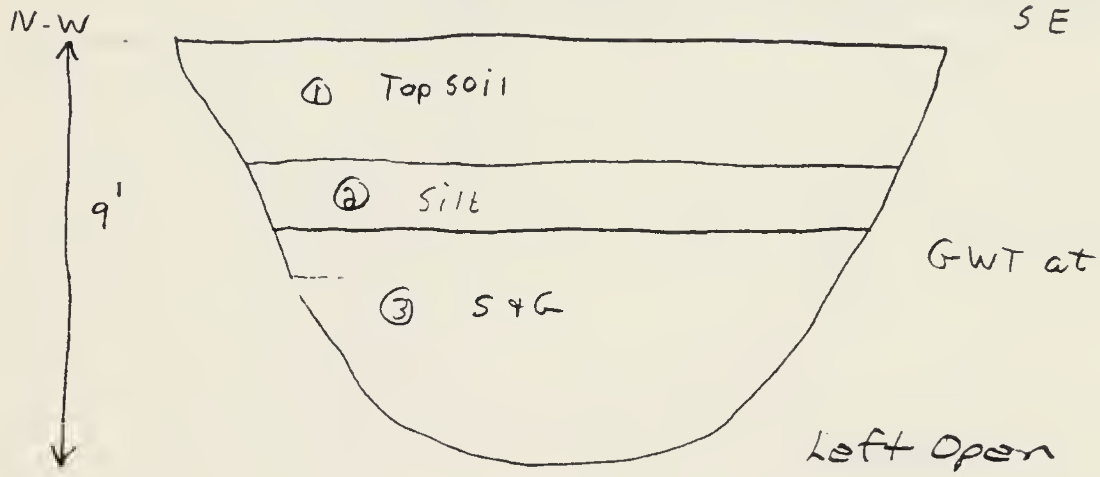
TP-185 Location: 350' N-W of TP-184 + ~~100~~ 80' S-E of old Pond 1 discharge channel; Coordinates: 812226N, 1171937E ZJO

Contractor: JCI Machine: 690 Excavator Operator: Rich Orher

Start: 1557 Finish: 1605

Photo: None

325' NE of Pond 1 toe trench ZJO



GWT at 2.8' on 1-17-91

Left Open

① 0-2.5' TOPSOIL: Dark Brown Sandy Silt; Top 6" Frozen root zone

② 2.5-4 SILT: Same as TP-176 From 1.2'-5'

③ 4-9' SAND + GRAVEL: Same as TP-176 From 6.3-11'; a little tougher to rip + bottom 2' of hole is real loose

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JOB NO. 3381-7A SUBJECT TP-186 SHEET NO. 1 OF 1

PROJECT WSP BY DATE 1-9-91

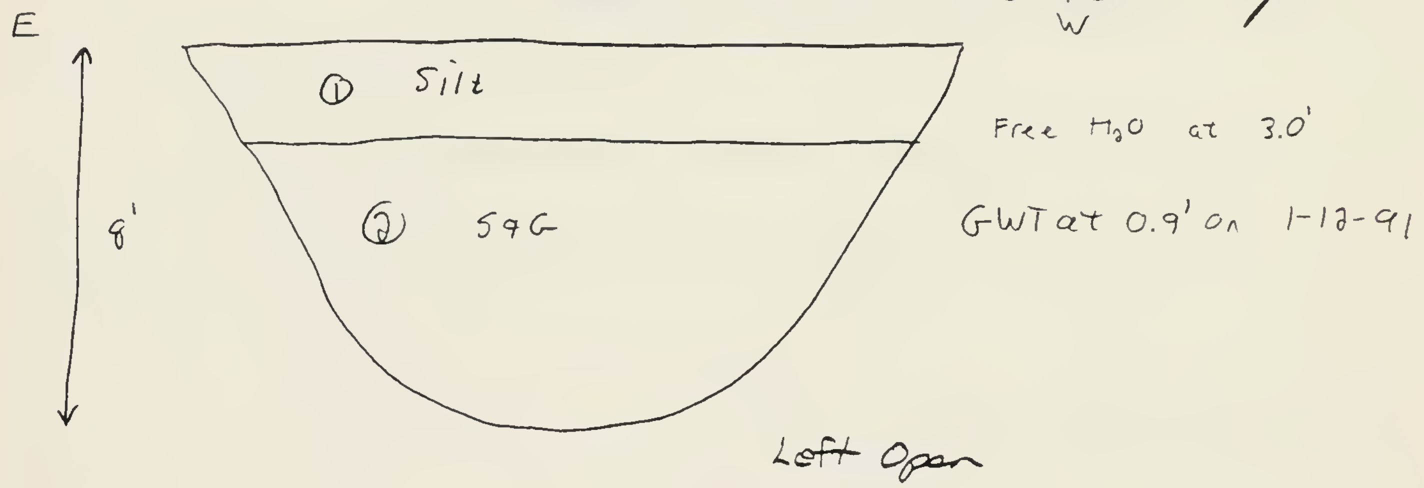
TP-186 Location: 220' N-E of TP-183 + 120 N-W of old Pond 1 discharge channel; Coordinates: 812363N, 1171628E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1610 Finish: 1620

Photo: None

200' NE of Pond 1 toe trench



① 0-2' SILT: Same as TP-176 From 1.2'-5'

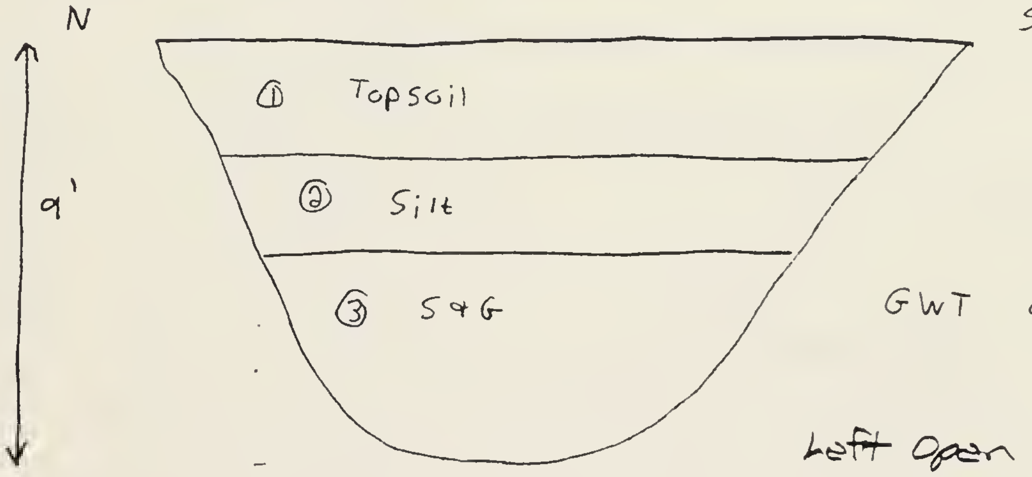
② 2'-8' SAND + GRAVEL: Same as TP-1761 From 6.3-11'

JOB NO. 3381-7A	SUBJECT TP-187	SHEET NO. 1	OF 1
PROJECT WSP		BY Jtc	DATE 1-9-91

TP-187 Location: 200' N of TP-186; 400' NE Pond 1 toe trench
Coordinates: 812569N, 1171669E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1625 Finish: 1630
Photo: None

the machine operated 8 hours on 1-9-91.
Total of 20 hours to date



GWT at 2.5' on 1-12-91

Left Open

① 0-2.5' TOPSOIL: Dark Brown to Black; Sandy Silt; slightly Plastic, Moist

② 2.5-4.5' SILT: Same as TP-176 From 1.2-5'

③ 4.5'-9' SAND & GRAVEL: Same as TP-176 From 6.3-11'; also contains some organics & cobbles up to 6"

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JOB NO. 3381-7A SUBJECT TP-188 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-10-91

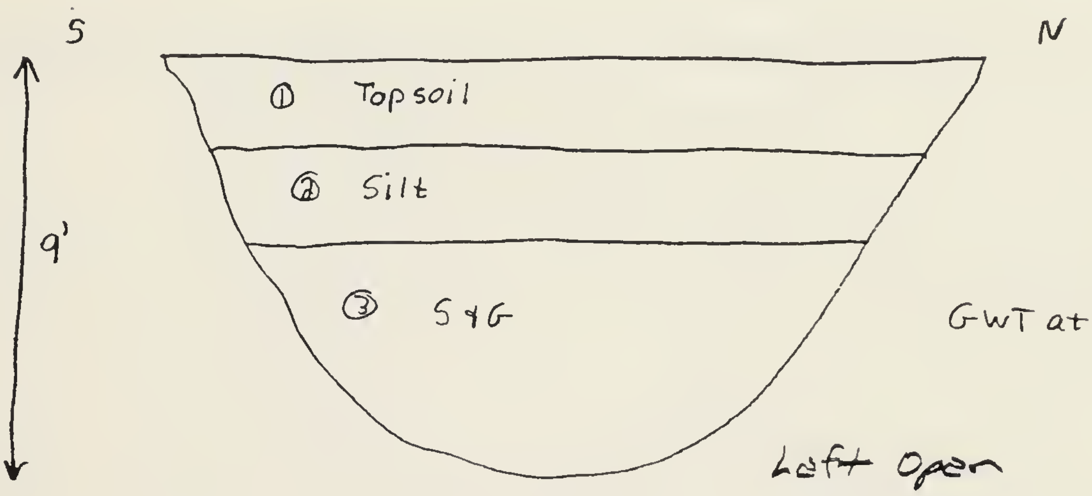
TP-188 Location: 300' N-E of TP-187; ~600' NE Pond 1 to trench

Coordinates: 812692N, 1171920E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0940 Finish: 0950

Photo: None



GWT at 2.0' on 1-12-91

Left Open

① 0-2' TOPSOIL: Medium Brown to Black sandy Silt; Slightly Plastic, Micaceous Moist

② 2-4' SILT: Same as TP-176 From 1.2-5'

③ 4'-9' SAND & GRAVEL: Same as TP-176. From 6.3-11'; heavily iron stained Layer From 4.0' to 4.2'; some 5" cobbles

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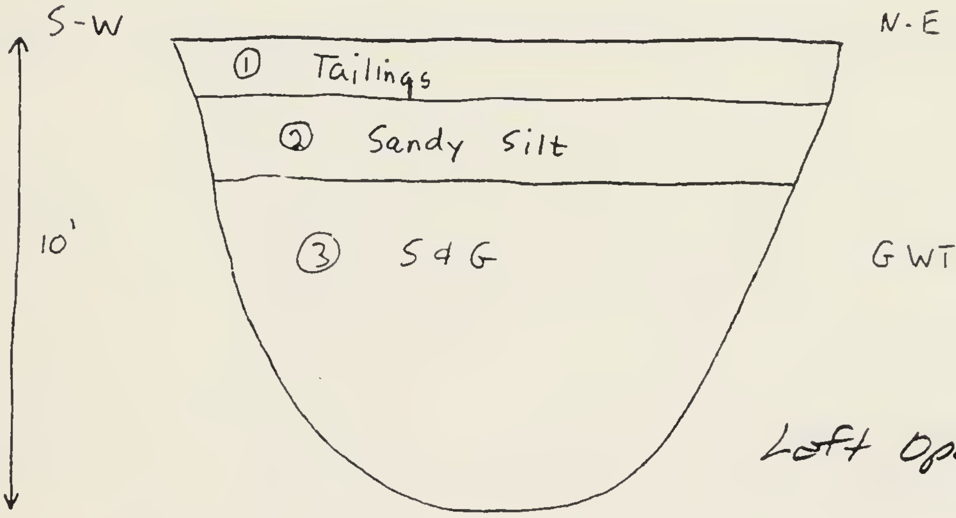
JOB NO. 3381-7A SUBJECT TP-189 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Ok DATE 1-10-91

TP-189 Location: 500' N-E of TP-188 & 125' W of lower Silver Bow Ck.
Coordinates; 812859N, 1172382E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1000
Photo: Roll 19 Frame 16 - shows Tailing TP-189
17 - shows pile of tailings East of TP-189



GWT at 1.9' on 1-12-91

Left Open

① 0-1.2' MIXED SOILS & TAILINGS

② 1.2-3' SANDY SILT: Black; 10-20% Fine sand; Plastic; very organic w̄ slight odor; Moist to Wet

③ 3'-10' SAND & GRAVEL: Light green to gray; 15% Fines, 70-80% Med Sand, becomes coarser & cleaner w̄ depth, very clean gravel, Loose & sluffing; saturated

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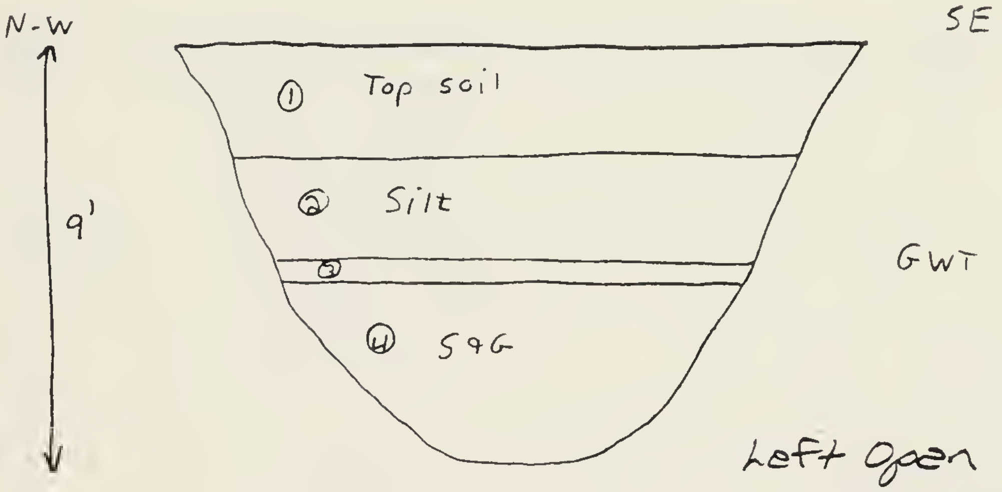
JOB NO. 3381-7A SUBJECT TP-190 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY Jtr DATE 1-10-91

TP-190 Location: 200' N-W of TP-189; ~800' NE Pond 1 toe trench
Coordinates: 812904 N, 1172193 E ZJA

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1035 Finish: 1045
Photo: None



GWT at 20' on 1-12-91

Left Open

① 0-2.3' TOPSOIL: Brown sandy silt, Plastic, Top 8" Frozen, Moist

② 2.3-4.5' SILT: Same as TP-176 From 1.2'-5'

③ 4.5-5' SANDY SILT w̄ some gravels: Dark green & red; 30-40% Fines 20-30% Fine sand; some iron stained Lenses

④ 5'-9' SAND & GRAVEL: Dark Gray to Black; Same as TP-176 From 6.3-11'

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JOB NO. 3381- 7A SUBJECT TP- 191 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

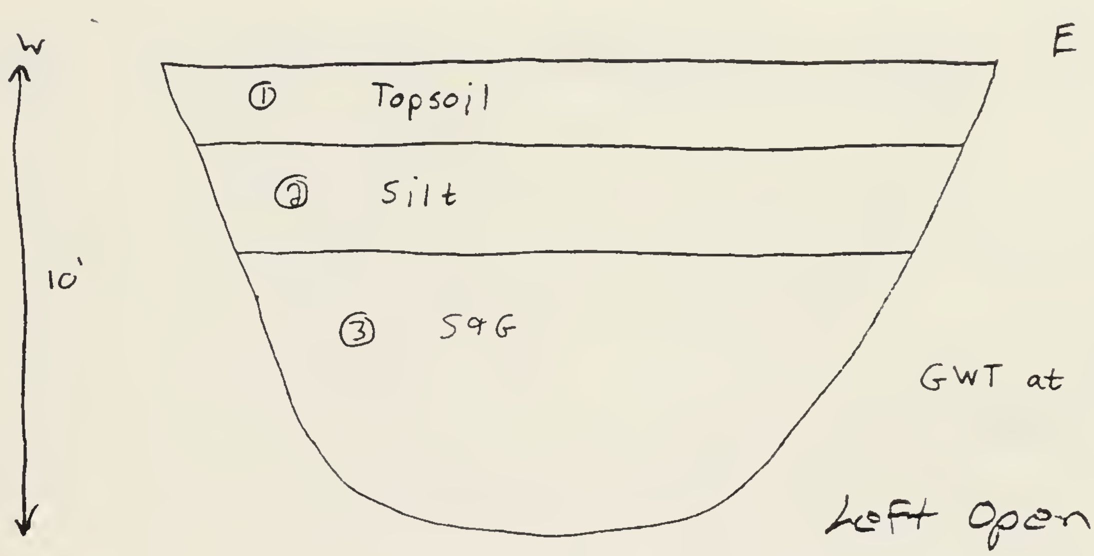
TP- 191 Location: 450' SW of TP-190; ~600 NE Pond 1 toe trench

Coordinates: 812866N, 1171745E

Contractor: JCI Machine: 690 Excavator Oprerator: Rich Orhen

Start: 1050 Finish: 1055

Photo: None



GWT at 0.8' on 1-12-91

Left Open

① 0-1.8' TOPSOIL: Lt Brown Sandy silt; Top 8" Frozen

② 1.8-4' SILT: Same as TP-176 From 1.2'-5'

③ 4'-10' SAND & GRAVEL: Lt green to Gray; Same as TP-176 From 6.3'-11'

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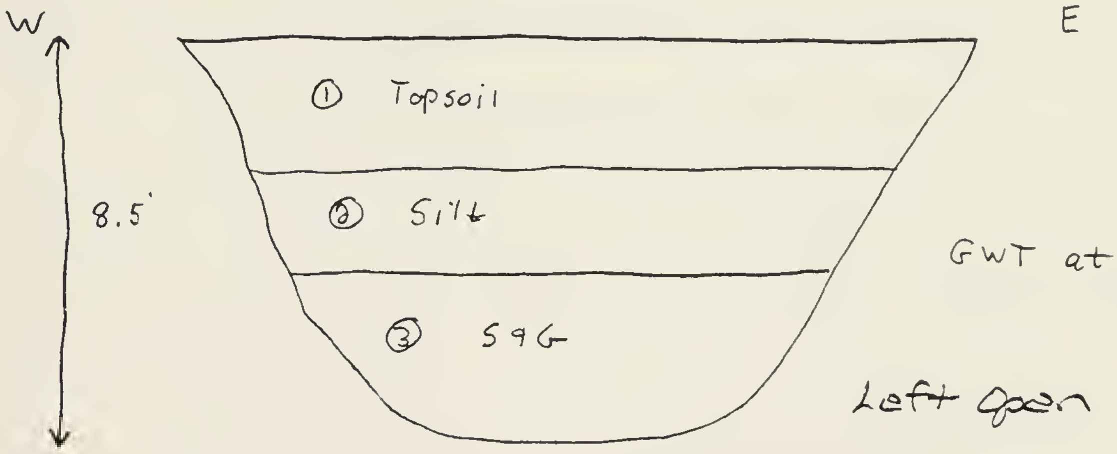
JOB NO. 3381-7A SUBJECT TP-192 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

TP-192 Location: 350' W of TP-191; ~400' NE Pond 1 toe trench
Coordinates: 812891 N, 1171421 E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1110 Finish: 1115
Photo: None



GWT at 2.5' on 1-12-91

Left Open

① 0-2.8' TOPSOIL: Dk gray on Top & turns Light gray w̄ depth; sandy silt; Slightly plastic w̄ some organics

② 2.8-5' SILT: Same as TP-176 From 1.2-5'

③ 5-8.5' SAND & GRAVEL: Dark greenish gray; Same as TP-176 From 6.3-11' up to 4" cobbles

JOB NO. 3381-7A SUBJECT TP-193 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jt DATE 1-10-91

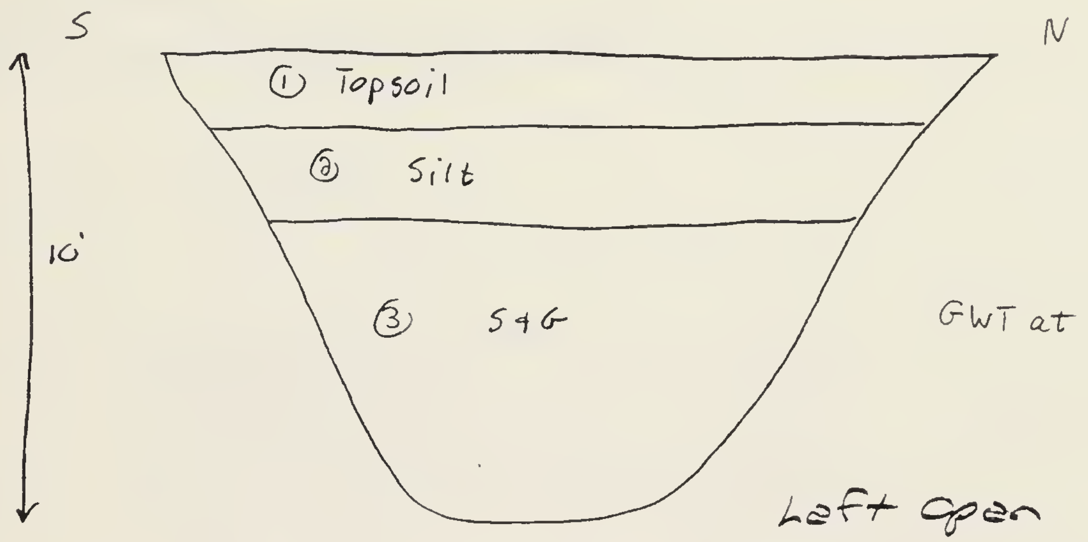
TP-193 Location: 200' SW of TP-192; ~200' NE Pond 1 toe trench

Coordinates: 812682N, 1171333E ZJD

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1116 Finish: 1125

Photo: None



GWT at 2.9 on 1-12-91

Left Open

① 0-1.5' **TOPSOIL**: Black + turns gray w depth; Sandy Silt, <5% Fine sand; Top 6" Frozen, some organics; Moist

② 1.5-3.5' **SILT**: Same as TP-176 From 1.2'-5'

③ 3.5-10' **SAND + GRAVEL**: Greenish Red + turns Gray w depth; Same as TP-176 From 6.3'-11'

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JOB NO. 3381-7A SUBJECT TP-194 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

Mill-Willow Bypass Right Bank Dike

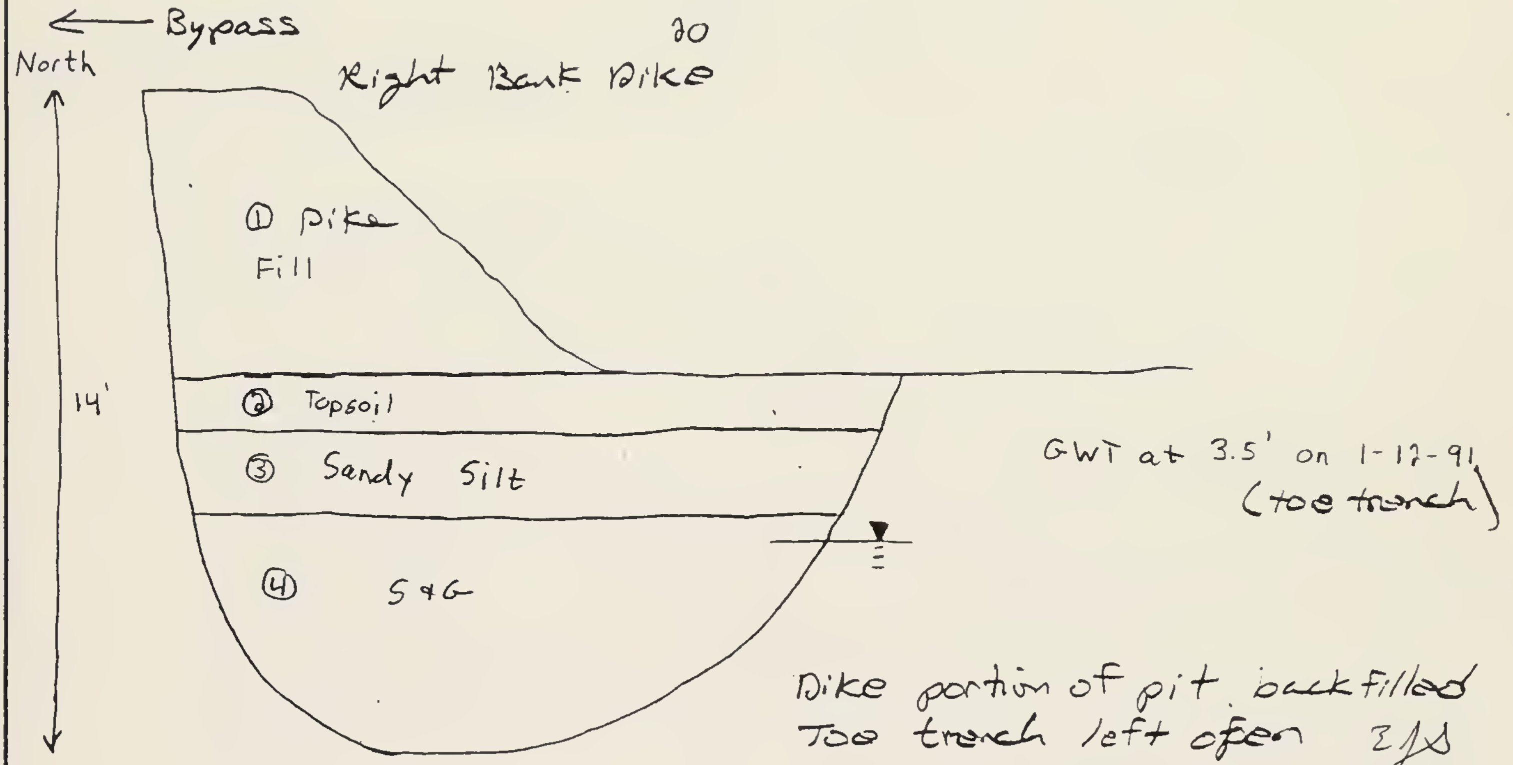
TP-194 Location: 530' N-W of TP-193; ~70' South of M-W Bypass

Coordinates: 813030N, 1170950E EJS

Contractor: JCI Machine: 690 Excavator Operator. Rich Orhen

Start: 1135

Photo: Roll 19 Frame 18 > taken in a vertical series
19
20



GWT at 3.5' on 1-12-91 (toe trench)

Dike portion of pit backfilled
Toe trench left open EJS

① 0-6' FILL: Light Brown; 30-40% Fines; Fine grained sand + some gravel; some silt Lenses, roots + other organics, some 4" cobbles

② 6-7.1' Topsoil: Black, highly organic sandy silt; Wet

③ 7.1-9.0' SANDY SILT: Gray to Light Brown; 5% Med Sand w̄ some gravel, Plastic, some organics, stiff while in place, Saturated

④ 9-14' SAND + GRAVEL: Same as TP-176 from 6.3-11'; Becomes quite dense at 13'; Saturated

Samples: 1 small Bag TP-194-1 4-5'
1 small Bag TP-194-2 8-8.5'

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JOB NO. 3381-7A SUBJECT TP-195 SHEET NO. 1 OF 1

PROJECT WSP Below Pond I BY Jt DATE 1-10-91

Right Bank Dike of M-Willow Bypass

TP-195 Location: 350' E of TP-194; ~70' south of M-W Bypass

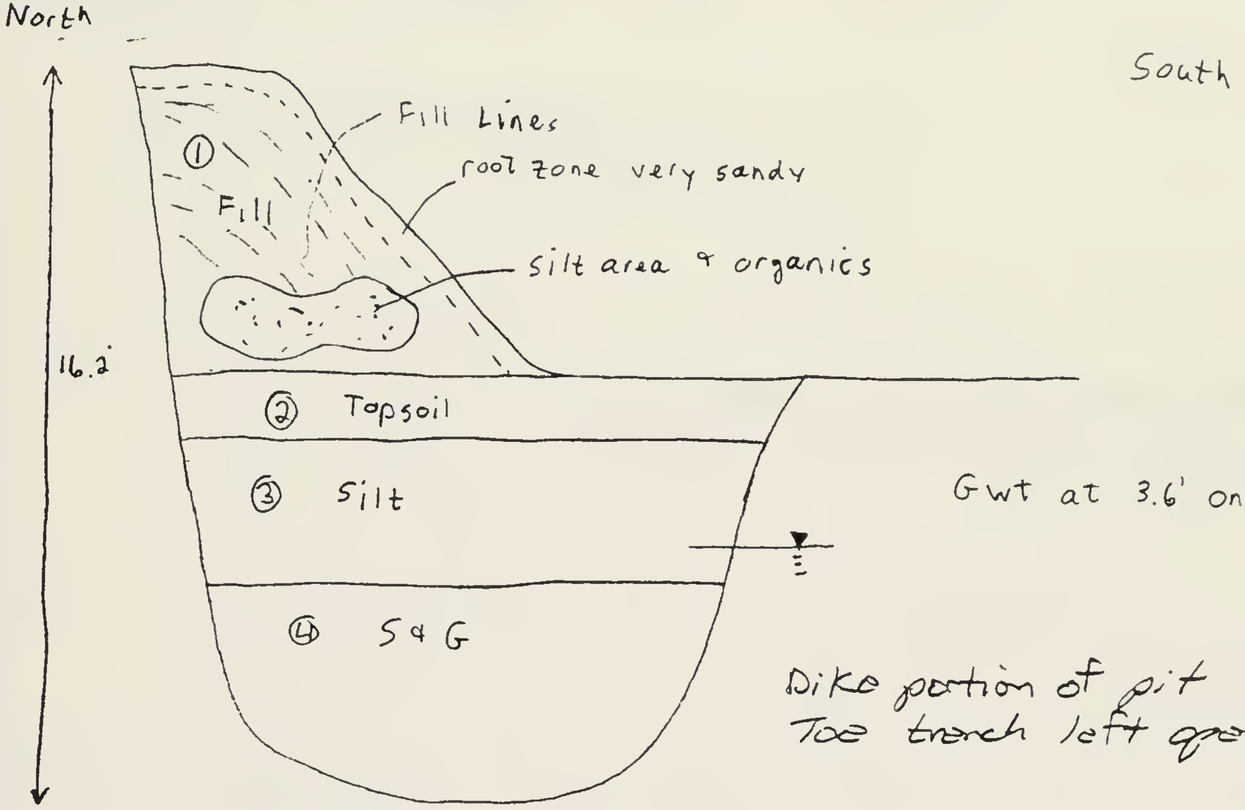
Coordinates: 813045N, 1171170E Zfo

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1310

Photo: Roll 19 Frame 21 > taken in a vertical series
22
23 & 24 & 25

← Bypass Roll 20 1



Gwt at 3.6' on 1-12-91 (toe trench)

Dike portion of pit backfilled
Toe trench left open Zfo

① 0-6.5' FILL: Lt Brown; sandy Gravelly silts; 40% Fines, 30% Sand, 20% gravels
Dry to Moist; Fairly dense, Some black silt Lenses w organics;
occasional cobbles

② 6.5'-8.0' TOPSOIL: Black; organic sandy silt, Moist

③ 8.0-11.5 SILT: Same as TP-176 From 1.2-5'

④ 11.5-16.2 SAND & GRAVEL: Same as TP-176 From 6.3-11'

Samples: 1 small bag TP-195-1, 3-4'

JOB NO. 3381-7A SUBJECT TP-196 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-10-91

TP-196 Location: 600' E of TP-195; Mill-Willow Bypass right bank dike

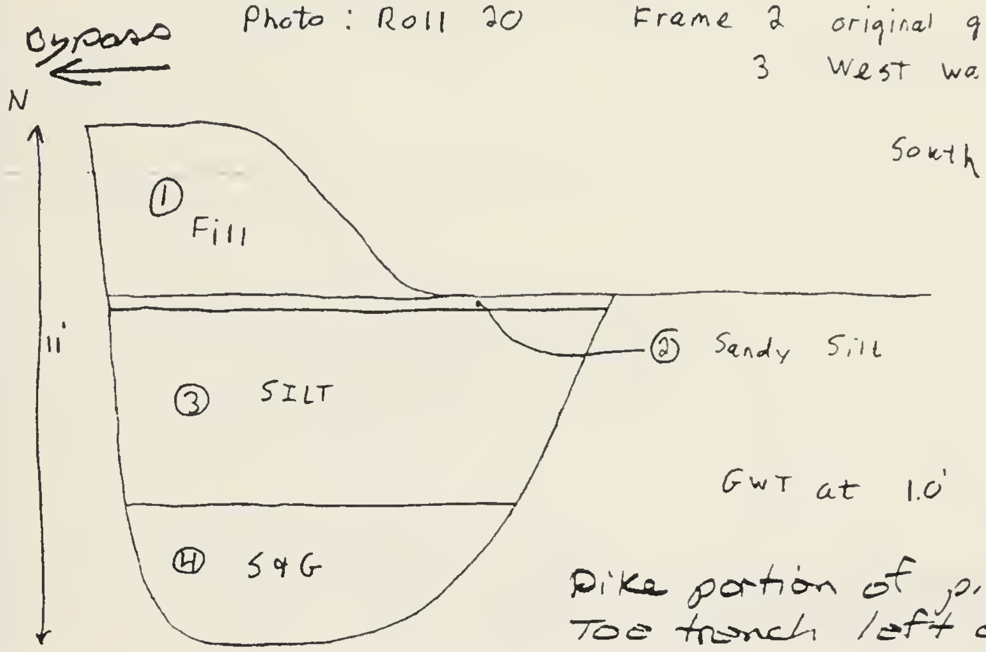
Coordinates: 813188N, 1171815E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orher

Start: 1340 Finish: 1350

Photo: Roll 20 Frame 2 original ground Level is shown in Bottom

3 West wall of trench



GWT at 1.0' on 1-12-91 (toe trench)

Dike portion of pit backfilled
Toe trench left open

① 0-3.5' FILL: Grayish brown; < 5% Fine sand, slightly Plastic, some organics
Moist

② 3.5-3.7' SANDY SILT: Dk Red, heavily iron stained, 5-10% Fine sand, slightly Plastic,
Some organics, Moist to wet

③ 3.7-8' SILT: Same as TP-176 From 1.2-5'

④ 8'-11' SAND + GRAVEL: DK GRAY to Black; same as TP-176 From 6.3-11'

Sample: 1 small bag TP-196-1 2.5'-3'

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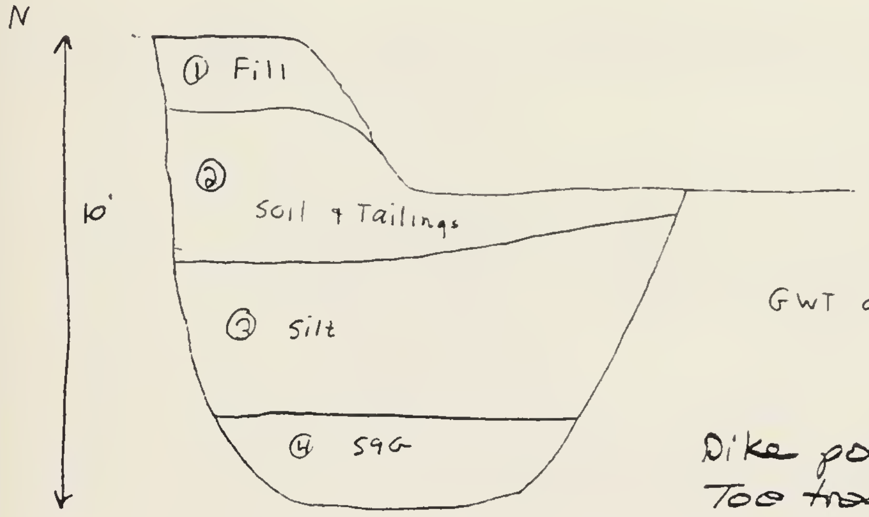
JOB NO. 3381-7A SUBJECT TP-197 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

TP-197 Location: 300' E of TP-196; Mill-Willow Bypass right bank dike
Coordinates: 813261N, 1172120E JJS
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1352 Finish 1410
Photo: Roll 20 Frame 4 Tailings in North end of trench
5 Looking N-W



GWT at 1' on 1-12-91 (in toe trench)

Dike portion of pit backfilled
Toe trench left open JJS

① 0-1.8' FILL: Dark Brown to Black Silty Sand, slightly Plastic, Some organics, Micaceous
Top 9" Frozen

② 1.8-4.8 MIXED SOIL + TAILINGS: Lt browns, Tans + yellows, some organics

③ 4.8-8 SILT: Dk Gray + Green; same as TP-176 From 1.2-5'

④ 8-10' SAND + GRAVEL: Dk Gray to Black, no iron stains; same as TP-176
From 6.3-11'

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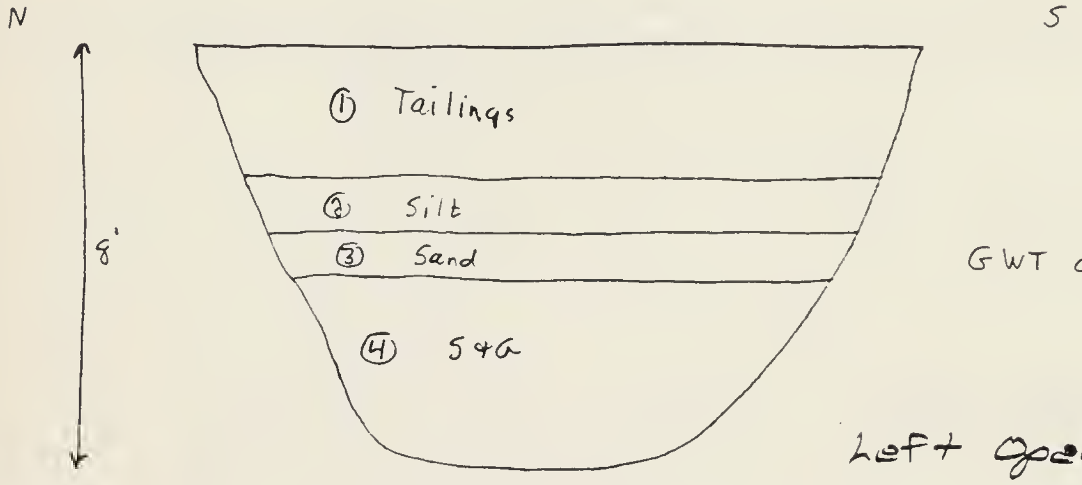
JOB NO. 3381-7A SUBJECT TP-198 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY JG DATE 1-10-91

TP-198 Location: 330' E of TP-197; ~70' south of lower Bypass
Coordinates: 812850N, 1172411E 2JS

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1415
Photo: Roll 20 Frame 6 Looking N-E



GWT at 2.8' on 1-12-91

Left Open

① 0-2.8' MIXED SOIL & TAILINGS: heavily Iron stained Fine to med sand, Micaceous Wet

② 2.8-4' SILT: Black; very organic, up to 5% Mica, saturated, 1" diameter roots

③ 4-5' SAND: Lt green & brown; Med to Fine "Quick" Sand, some organic & Silt Lenses; saturated

④ 5'-8' SAND & GRAVEL: DK gray to Black; same as TP-176 From 6.3-11'

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JOB NO. 3381-7A SUBJECT TP-199 SHEET NO. 1 OF 1

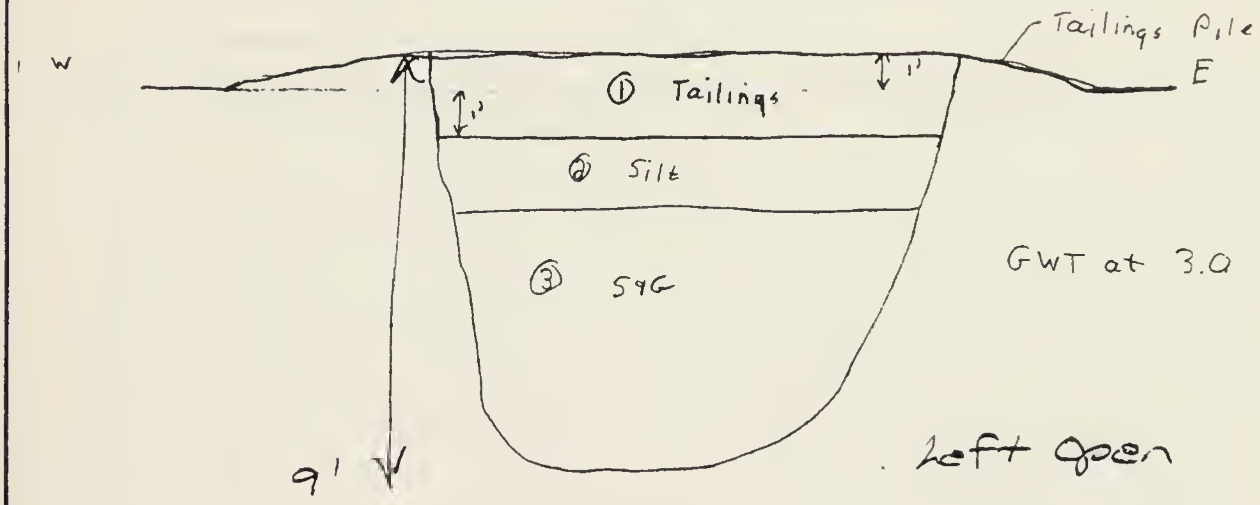
PROJECT WSP Below Pond 1 BY Jte DATE 1-10-91

TP-199 Location: 230' E of TP-198; 50' south lower Silver Bow Ck & north side of access road; Coordinates: 813426N, 1172710E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1428

Photo: Roll 20 Frame 7 Facing N-E



GWT at 3.0 on 1-12-91

Left open

① 0-2' MIXED SOIL & TAILINGS: Tan & Lt Brown very Fine sand, some organics, Moist

② 2-3.5' SILT: Black; very organic, slightly plastic, some slussing, 1" diameter roots; saturated

③ 3.5-9' SAND & GRAVEL: Lt green & Gray; no iron staining; Same as TP-176 6.3-11'

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JOB NO. 3381-7A SUBJECT TP-200 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-10-91

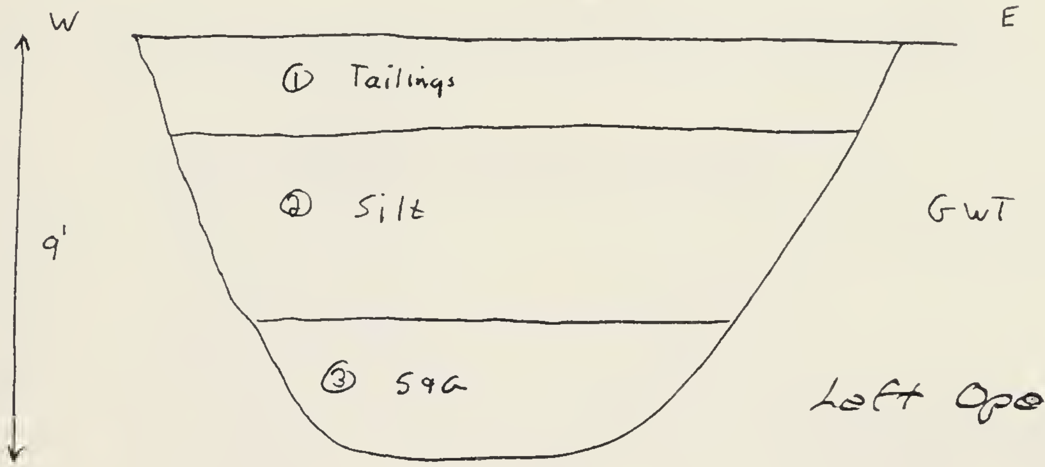
TP-200 Location: 700' N-W of TP-199; ~100'E of lower Silver Bow CK.

Coordinates: 813865N, 1172181E

Contractor. JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1455 Finish: 1505

Photo: Roll 20 Frame 8 North Wall



GWT at 4.5' on 1-12-91

Left Open

① 0-2' MIXED SOIL & TAILINGS: Tans & browns; Fine grained iron stained sand Lenses, Top 1.5' Frozen

② 2-6' SILT: Black sandy silt; 5% Fine sand, very organic w̄ 1" roots Saturated

③ 6-9' SAND & GRAVEL: Grayish Black; Micaceous, same as TP-176 6.3'-11'

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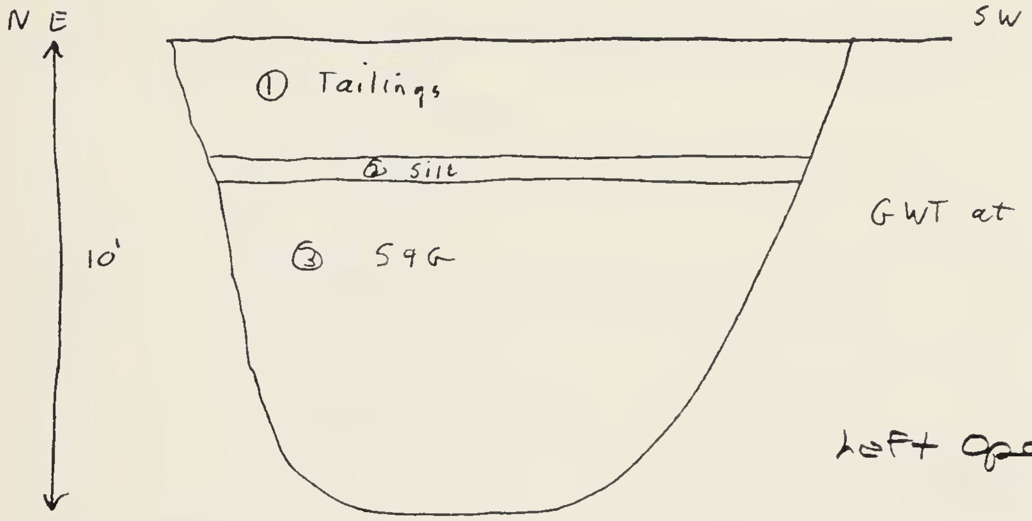
JOB NO. 3381-7A SUBJECT TP-201 SHEET NO. 1 OF 1

PROJECT WSP BY Jc DATE 1-10-91

TP-201 Location: 320' N of TP-200; ~100' E of lower Silver Bow Ck
Coordinates: 814122N, 1172078E
Contractor: JCI Machine 690 Excavator Operator: Rick Orhen

Start: 1510 Finish 1520
Photo: Roll 20 Frame 9



GWT at 4.5' on 1-12-91

Left open

① 0-2.5' MIXED SOILS & TAILING: Browns, Tans & yellows, 4" root Zone, Top 8" Frozen

② 2.5'-3.0' SILT: Same as TP-200 2-6'

③ 3-10' SAND & GRAVEL: Lt green & gray; no iron stain, same as TP-176 6.3-11'

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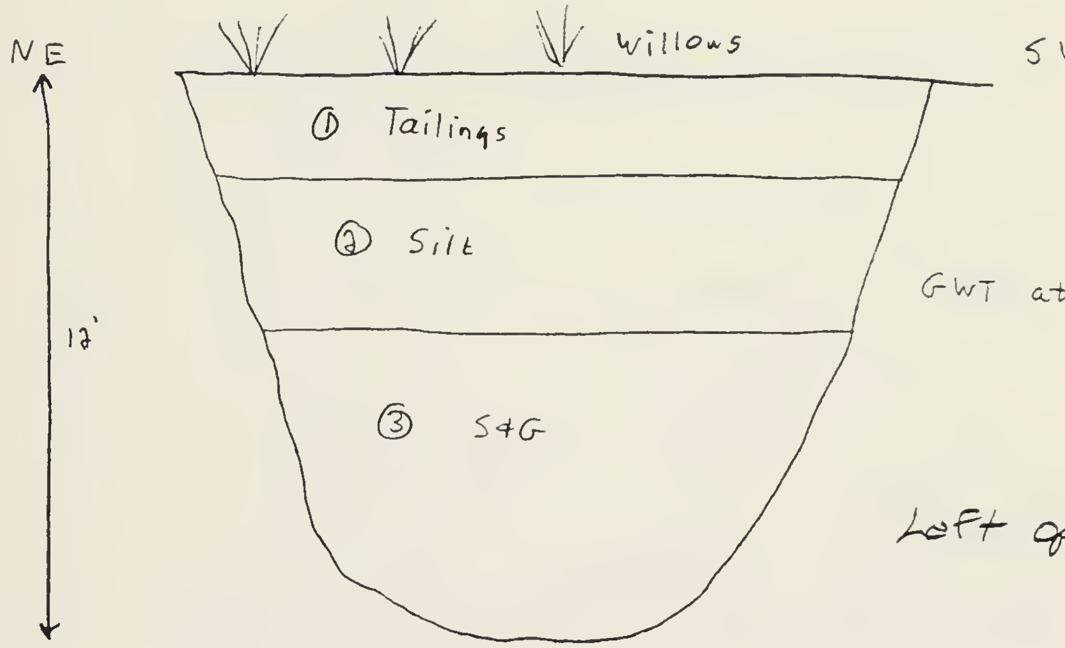
JOB NO. 3381-7A SUBJECT TP-202 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

TP-202 Location: 230' N-W of TP-201; ~100 E of lower Silver Bow Ck
Coordinates: 814312N, 1171988E Efs
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1524 Finish: 1535
Photo: Roll 20 Frame 10



GWT at 4.0 on 1-12-91

Left open

① 0-2.1' MIXED SOIL + TAILINGS: Yellow + brown + some iron stained fine grained sand; Dry to Moist

② 2.1-5.4' SILT: Black; very organic, some peat, roots, wet

③ 5.4-12' SAND + GRAVEL: Black + turns to DK Gray w̄ depth; Very iron stained from 5.4 to 6.0'; Becomes cleaner w̄ depth; material is very loose + acts like Quick sand; not as coarse or as dense as other holes; saturated

JOB NO. 3381-7A SUBJECT TP-203 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jtc DATE 1-10-91

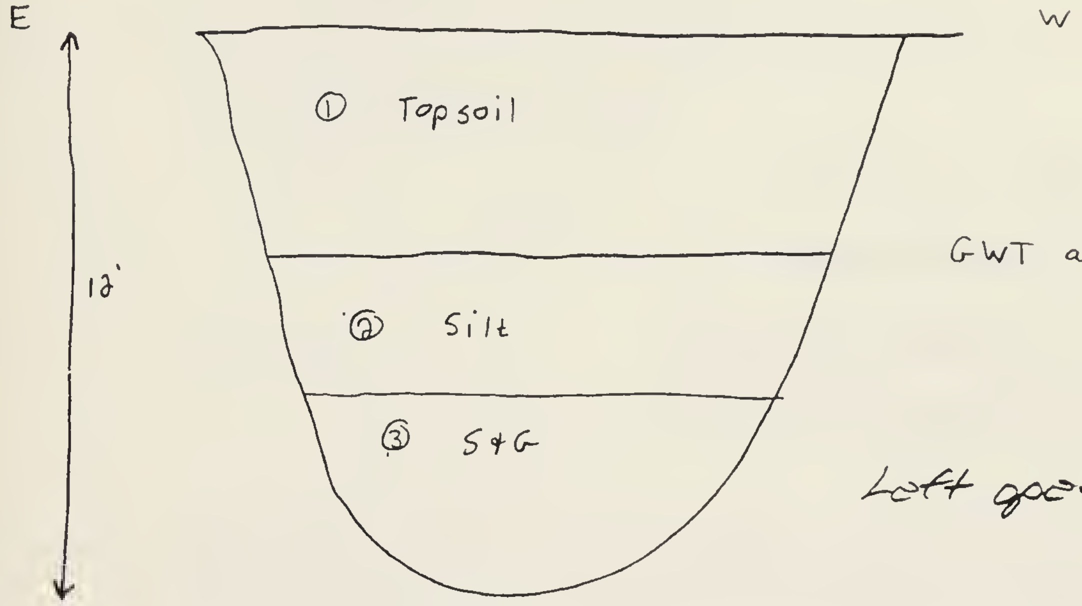
TP-203 Location: 330' N-E of TP-202; ~100'E of Clark Fork River

Coordinates: 814440N, 1172310E EJS

Contractor: JCI Machine: 690 Excavator Operator: Rich Orher

Start: 1542 Finish: 1550

Photo: None



GWT at 5.0' on 1-12-91

Left open

① 0-4.8' TOPSOIL: Black & DK Brown, organic, micaceous; slightly plastic, Tan Lense of silt From 4.0 - 4.4'; Moist to wet

② 4.8-7.7 SILT: Grayish Black, 5-10% Fine sand, 5% gravel; some organics material is Fairly stiff; Wet to Saturated

③ 7.7 - 12' SAND & GRAVEL: Lt green to Gray; no iron stained Lenses; same as TP-176 6.3 - 11'

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JOB NO. 3381 - 7A SUBJECT TP- 204 SHEET NO. 1 OF 1

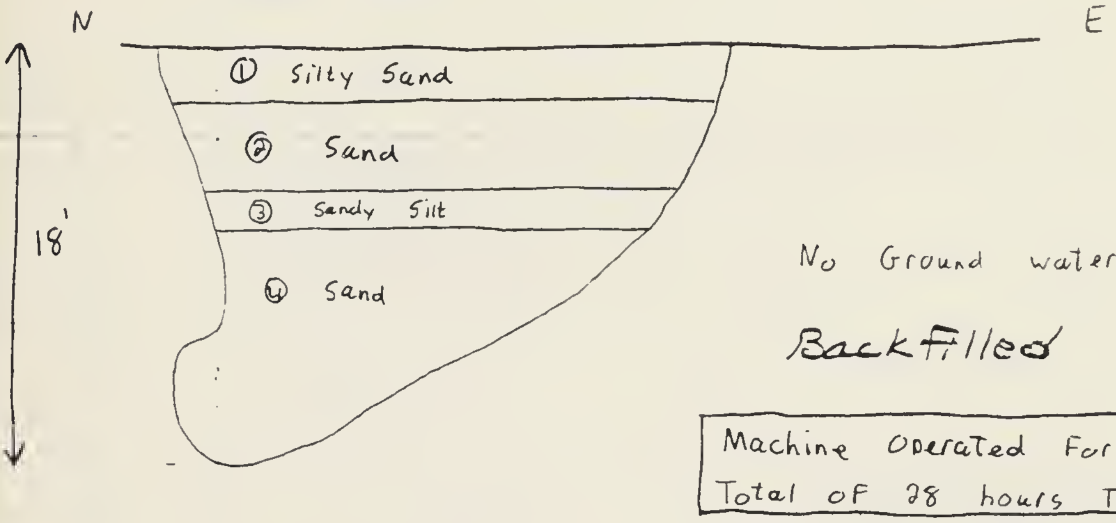
PROJECT WSP Below Pond 1 BY DATE 1-10-91

TP- 204 Location: 900' S-E of TP-203; ~300' NE of lower Silver Bow Ck.; east fan / terrace Coordinates: 813946N, 1173048E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orher

Start: 1605 Finish: 1620

Photo: None



No Ground water

Backfilled

Machine Operated For 8 hours on 1-10-91 Total of 28 hours To date

① 0-2.8' SILTY SAND: Brown; 10-20% Fines, Med to Coarse sand, some organics; some cobbles up to 4" size increases w depth; Moist

② 2.8-6.2' SAND: Brown; 5% Fines, Fine to Med sand, does not sluff, some 1' boulders, Moist

③ 6.2-8' SANDY SILT: Brown; appears slightly Plastic, no sluffing; 1' Boulders Moist

④ 8-18' SAND: Brownish Red 5% Fines, no cobbles, Loose, Moist, Micaceous some gravels, Some 1' Boulders

Sample: 1 small bag TP-204-1 12-12.5'

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JOB NO. 3381 - 7A SUBJECT TP- 205 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-11-91

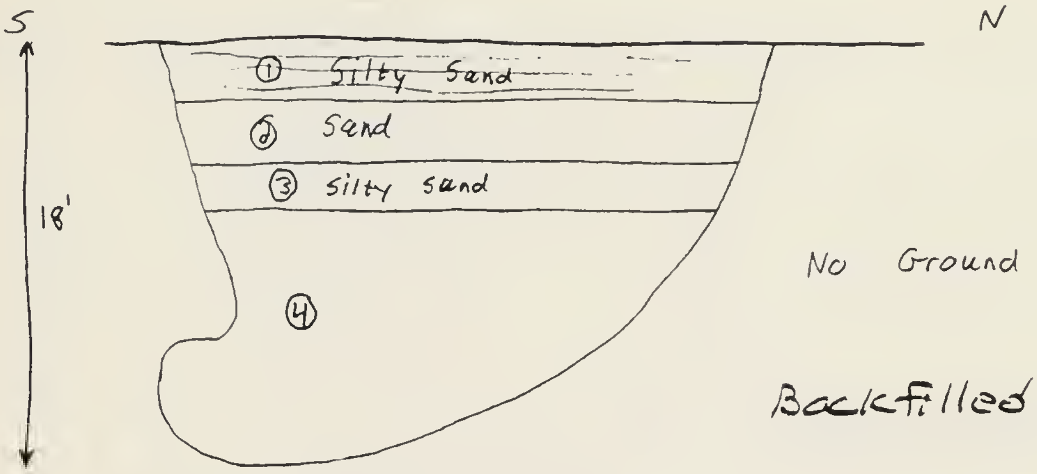
TP-205 Location: 440' S-E OF TP-204; old railroad grade

Coordinates: 813781N, 1173434E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0823 Finish: 0837

Photo: None



No Ground H_2O

Backfilled

① 0-2.7' SILTY SAND: Brown; 5-10% Fines, 10% Gravel; deposited in Layers, No sluFFing; Dry to Moist

② 2.7-5' SAND: Brown; <5% Fines, 10% gravel, clean, Fine to Coarse Sand, sluFFs, Loose, Moist, Micaceous

③ 5-7' SILTY SAND: Dark Brown to Black; 5-10% Fines, 10% Gravel, From 5.5' to 6' there is a gravel Layer, some organics, Micaceous, Moist

④ 7-18' SAND: Brownish Red, 5% Fines, no cobbles, Loose, Moist, Micaceous, some gravels

Samples;	1 small bag	TP-205-1	3.5' - 4.0'
	1 small bag	TP-205-2	6.0 - 6.5 (could not get a sample that was really represenative)

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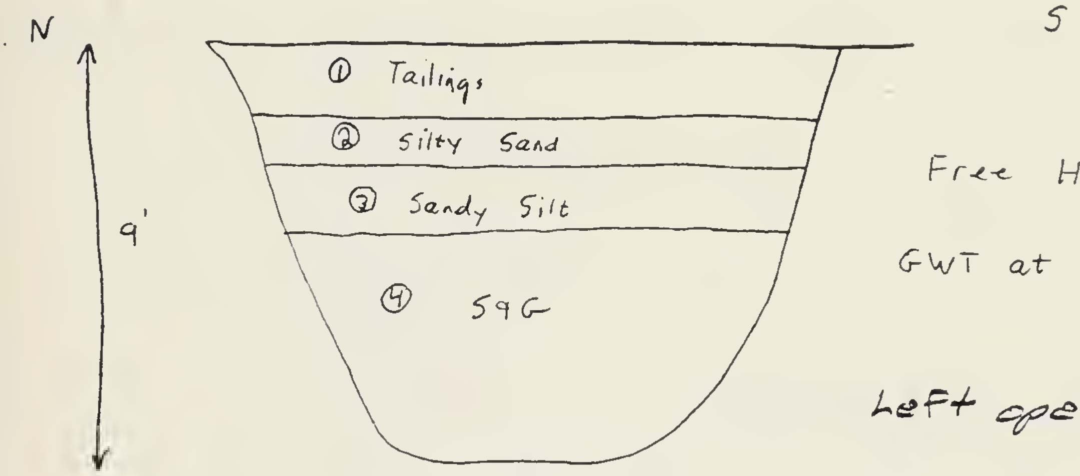
JOB NO. 3391-7A SUBJECT TP-206 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY Jtc DATE 1-11-91

TP-206 Location: 800' SW of TP-205; ~300'E of old Silver Bow channel
Coordinates: 813088N, 1172973E Ejl
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0850
Photo: Roll 20 Frame 11 West wall



Free H_2O at 5.8'

GWT at 4.0' on 1-12-91

Left open

① 0-1.5 MIXED SOILS + TAILINGS: Tan & Brownish Red Lenses, Top 12" Frozen

② 1.5-2.5 SILTY SAND: Brownish Red; 5-10% silt, Very Fine sand, Micaceous, Slightly iron stained, Moist

③ 2.5-4 SANDY SILT: Black to Dark Gray; 5-10% very Fine sand, slightly stiff, Micaceous, some organics, wet

④ 4-9' SAND & GRAVEL: Dark Gray to Black; no iron stain; same as TP-176 From 6.3-11'

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JOB NO. 3381-7A SUBJECT TP-207 SHEET NO. 1 OF 1

PROJECT WSP Below Pond BY DATE 1-11-91

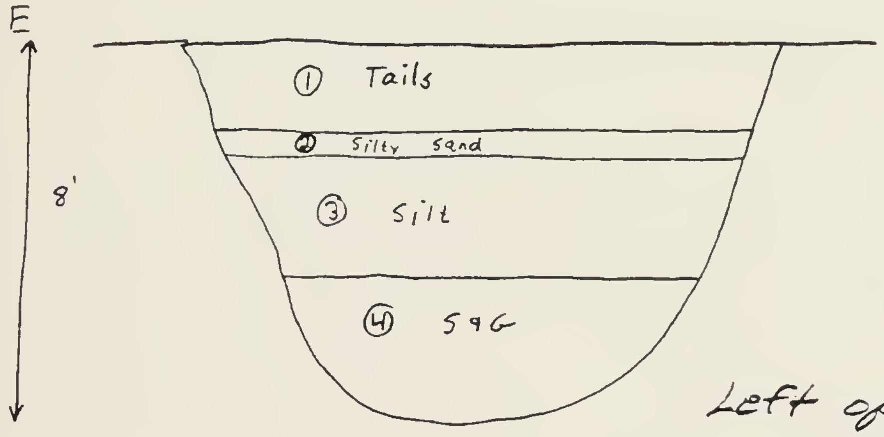
TP-207 Location: 200' W of TP-206; ~100' E of old Silver Bow channel

Coordinates: 813080N, 1172741E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0903 Finish: 0910

Photo: Roll 20 Frame 12



Free H_2O at 3.0'

GWT at 1.7' on 1-12-91

Left open

① 0-1.9 MIXED SOIL & TAILINGS: Tan & Brown w̄ Gray Mottling

② 1.9-2.3' SILTY SAND: Same as TP-206 From 1.5'-2.5'

③ 2.3'-5.0' SILT: Dark Gray to Black; plastic; some organics, sticky, Fairly stiff
Some 1" roots

④ 5-8' SAND & GRAVEL: Light Green to Gray; some organics; same as TP-176 From 6.3'-11'

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JOB NO. 3381 SUBJECT TP-208 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jkc DATE 1-11-91

TP-208

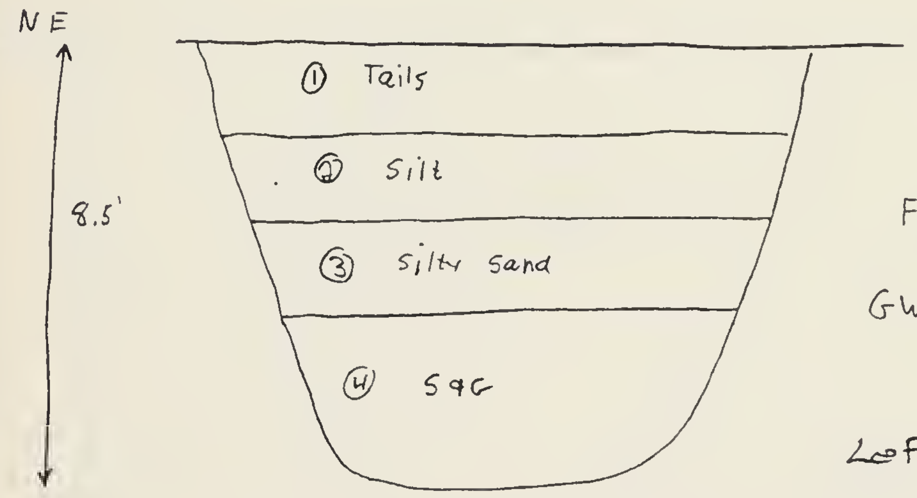
Location: 330' S of TP-207; & ~100' E of well GW12
~200' E of old Silverbow Ck

Coordinates: 212803N, 1172835E Z/S

Contractor: JCI Machine: 690 Excavator Operator: Orhen

Start: 0935

Photo: Roll 20 Frame 13 S-E wall
14 N-W wall, shows silty sand Layer, 3.8 - 5.8'



Free H_2O at 4.5'

GWT at 2.0' on 1-12-91

Left open

① 0-2' MIXED SOILS & TAILINGS: Grays & Light Browns, iron stained sand Lenses, Top 12" Frozen

② 2-3.8 SILT: Black & Dk Gray; 5% Fine sand, gritty, Micaceous, Plastic, roots and other organics, wet to saturated

③ 3.8-5.8' SILTY SAND: Reddish Brown, material coarsens w depth, heavily iron stained Lenses, Some black Lenses, some gravels, Micaceous saturated

④ 5.8'-8.5' SAND & GRAVEL: Light Green, 5.8' to 6.8' Loose silty gravelly sand; Some organics, cobbles up to 5"; some iron stained Lenses; material becomes Coarser, cleaner & denser w depth, Saturated

Samples:	1 small bag	TP-208-1	2.5'-3'
	1 small bag	TP-208-2	4.0-4.5'

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JOB NO. 3381-7A SUBJECT TP-209 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-11-91

TP-209

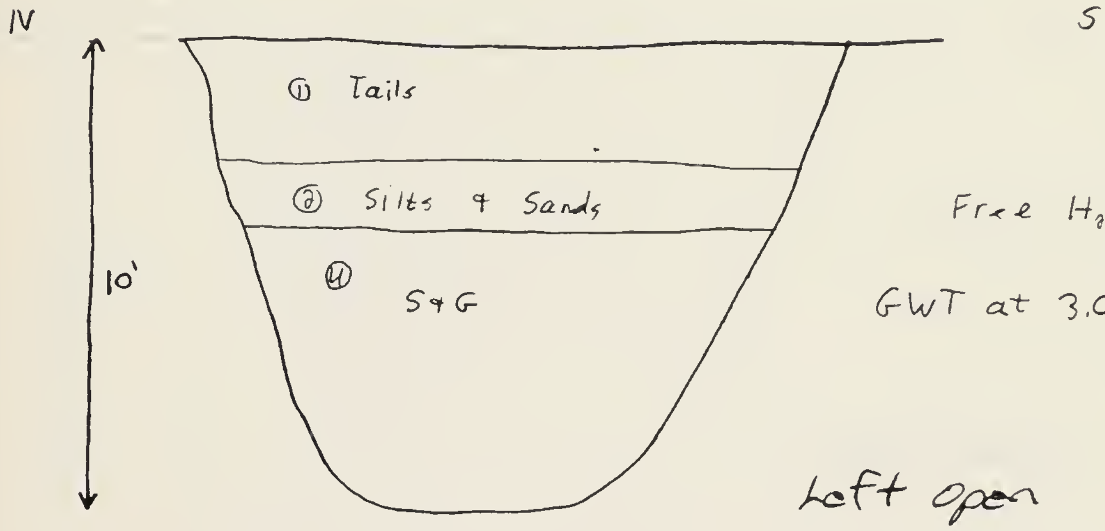
Location: 360' S of TP-208; ~100'W of old Silver Bow Ck

Coordinates: 812408 N, 1172747 E

Contractor: JCI Machine: 640 Excavator Operator: Rich Orhen

Start: 1010 Finish: 1085

Photo: Roll 20 Frame 15 East wall of TP



Free H_2O at 5'

GWT at 3.0' on 1-12-91

Left open

① 0-2.5' MIXED SOILS + TAILINGS: Light Brown, Tans + yellows, gray mottling, Top 2.3' Frozen

② 2.5-4' SILTS + SANDS: Reddish brown; sandy silt + turns to silty sand w̄ depth; some iron stained Lenses; some organics, Plastic, Micaceous, wet

③ 4-10' SAND + GRAVEL: Lt green to Dark Gray, Some roots; Same as TP-176 From 6.3' - 11'

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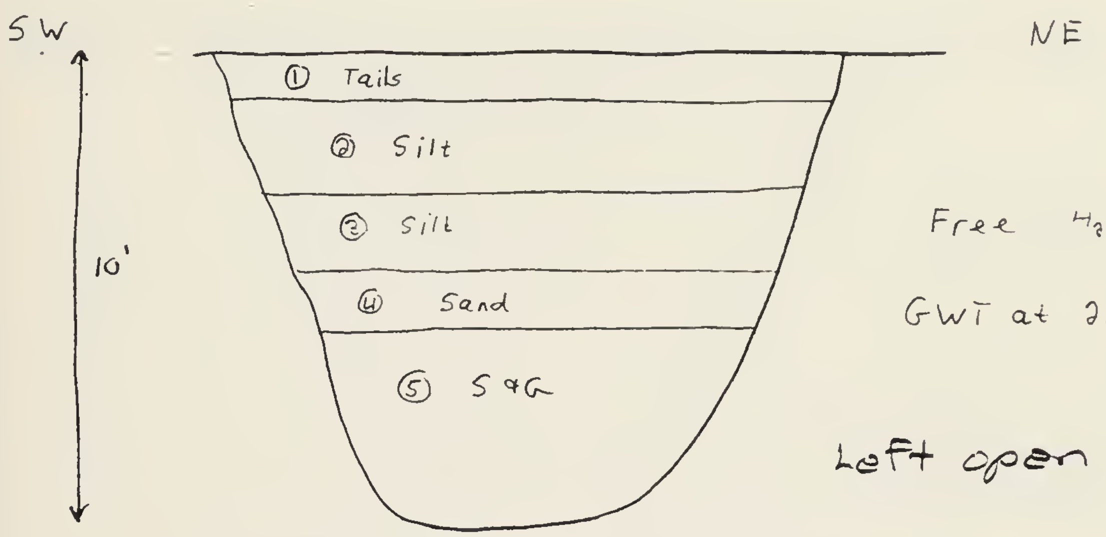
JOB NO. 3391-7A SUBJECT TP-210 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY Gtr DATE 1-11-91

TP-210 Location: 340' N-W of TP-209; ~50' S of old Silver Bow Channel
Coordinates: 812630N, 1172540E zjs
Contractor: JCI Machine: 690 Excavator Operater: Rich Orhen

Start: 1030 Finish: 1050
Photo: Roll 20 Frame 16 S-E wall



Free H_2O at 4.8'

GWT at 2.1 on 1-12-91

Left open

① 0-1' MIXED SOILS + TAILINGS: Light Brown to Dk red

② 1-3' SILT: Black + turns to Gray w̄ depth; organic, Micaceous, Plastic, very Fine "gritty" sand, small roots, saturated

③ 3'-4.8' SILT: Dk Gray; small organics; the material in this layer is made up of little balls of clay or silt, Micaceous, saturated

④ 4.8-6.0' SAND: Light Green; Fairly Clean Med grained sand; some iron stained lenses; 1" roots; Micaceous; sluffs; saturated

⑤ 6-10' SAND + GRAVEL: Light Green; up to 4" cobbles, same as TP-176 6.3-11

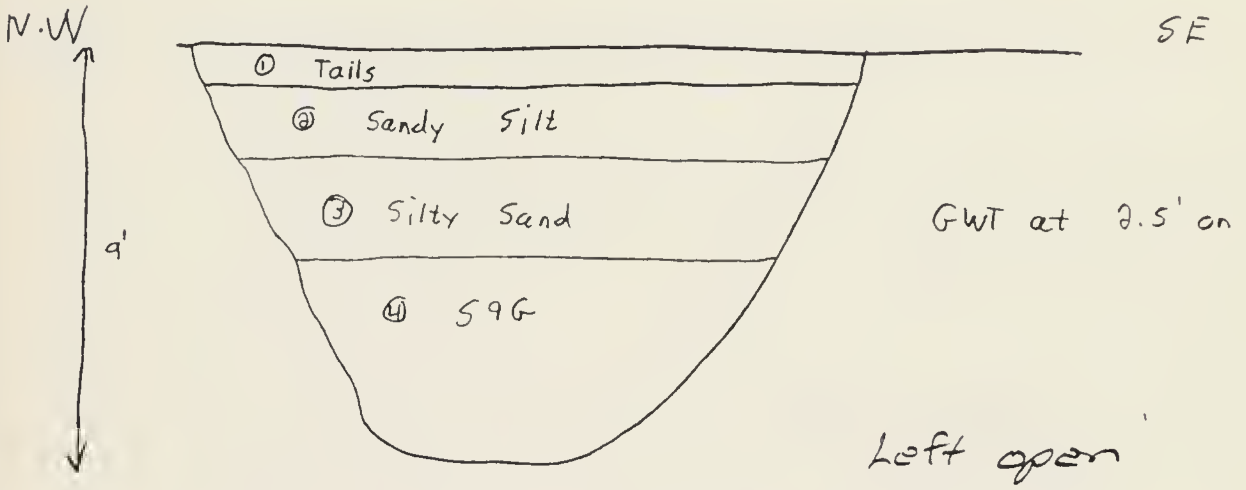
Samples: 1 small bag TP-210-1 2.5-3'
1 small bag TP 210-2 3.2-3.7'

JOB NO. 3381-7A SUBJECT TP-211 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jk DATE 1-11-91

TP-211 Location: 670' SE of TP-210; ~600' NE of Pond 1 toe trench
Coordinates: 811986 N, 1172726E
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start 1120 Finish: 1122
Photo: Roll 20 Frame 12 ☆ Photo did not turn out



GWT at 2.5' on 1-12-91

Left open

① 0-0.8' TAILINGS: Tans, Light Browns & yellows

② 0.8'-2.3' SANDY SILT: Dark Gray on Top & turns Black w depth; roots and other organics; wet 20% Fine sand

③ 2.3-4.5' SILTY SAND: 20% Fines; Med to coase sand, Saturated; some iron stained sand, Roots

④ 4.5-9' SAND & GRAVEL: Light geen to Gray, Same as TP-176 From 6.3-11'

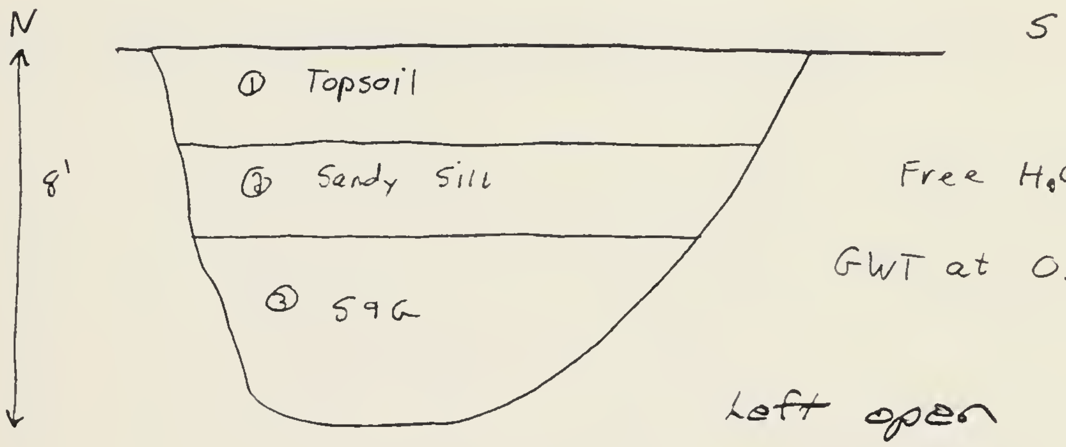
ESA Consultants

JOB NO. 3381 - 7A SUBJECT TP- 212 SHEET NO. 1 OF 1
PROJECT WSP BY Jtc DATE 1-11-91

TP- 212 Location: 380' W of TP-211; ~450' NE of Pond 1 toe trench
Coordinates: 811975N, 1172376E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1140 Finish: 1145
Photo: Roll 20 Frame 18 Did not turn out



Free H_2O at 4'

GWT at 0.4' on 1-12-91

Left open

① 0-2' TOPSOIL: Dk Gray Sandy Silt, <5% Sand, slightly plastic
some organics & roots, Moist

② 2'-4' SANDY SILT: Dark Brown & Gray; 5-10% sand, Plastic, Saturated

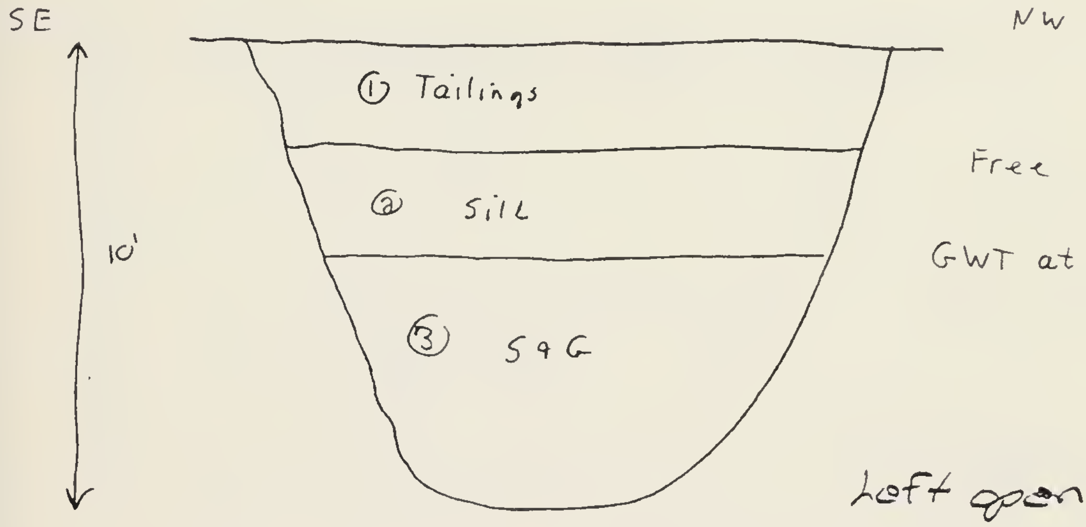
③ 4'-8' SAND & GRAVEL: Same as TP-176 6.3-11'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-213 SHEET NO. 1 OF 1
PROJECT WSP Below Pond 1 BY DATE 1-11-91

TP-213 Location: 940' S.E of TP-212; ~550' N of Pond 1 toe trench
Coordinates: 811547N, 1173176E
Contractor: JCI Machine: 690 Excavator Operator: Rick Orher

Start: 1405 Finish: 1420
Photo: Roll 20 Frame 19 Did not turn out



Free H_2O at 3.3'

GWT at 1.8' on 1-12-91

Left open

① 0-2.2' TAILINGS: Same as usual, Top 1.8' Frozen

② 2.2-4.6' SILT: Black + Dark Gray; <5% Fine sand, organic, Micaceous, Plastic, sticky, saturated

③ 4.6-9' SAND & GRAVEL: Black + Dark Gray, no iron stain; Same as TP-176 6.3-11', some organics

ESA Consultants

JOB NO. 3381 SUBJECT TP-214 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-1-91

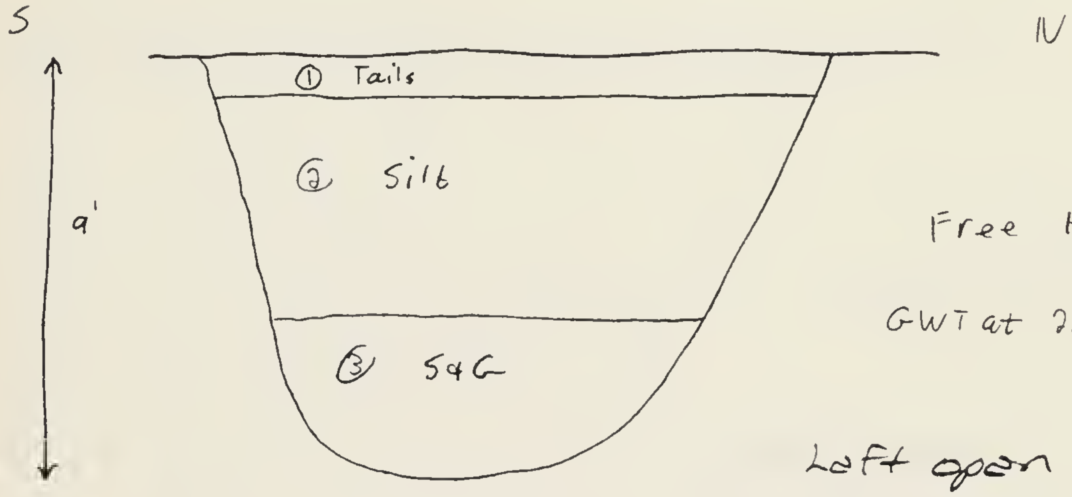
TP-214 Location: 200' S-W From TP-213; ~ 451 N of Pond 1 toe trench ~ 60' N of well GW-02

Coordinates: 811463N, 1172983E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orken

Start: 1430 Finish: 1440

Photo: Roll 20 Frame 20 Did not turn out



Free H_2O at 4.0'

GWT at 2.3' on 1-12-91

Left open

① 0-0.9' TAILINGS: organics + typical Tails

② 0.9'-5.5' SILT: Black + turns Gray w depth; organics, Micaceous, some Balls of material in Gray area; gets stiffer w depth, Plastic Saturated

③ 5.5'-9.0' SAND + GRAVEL; Dark Gray; same as TP-176 6.3-11'

ESA Consultants

JOB NO. 3381 SUBJECT TP-215 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Gk DATE 1-11-91

TP-215

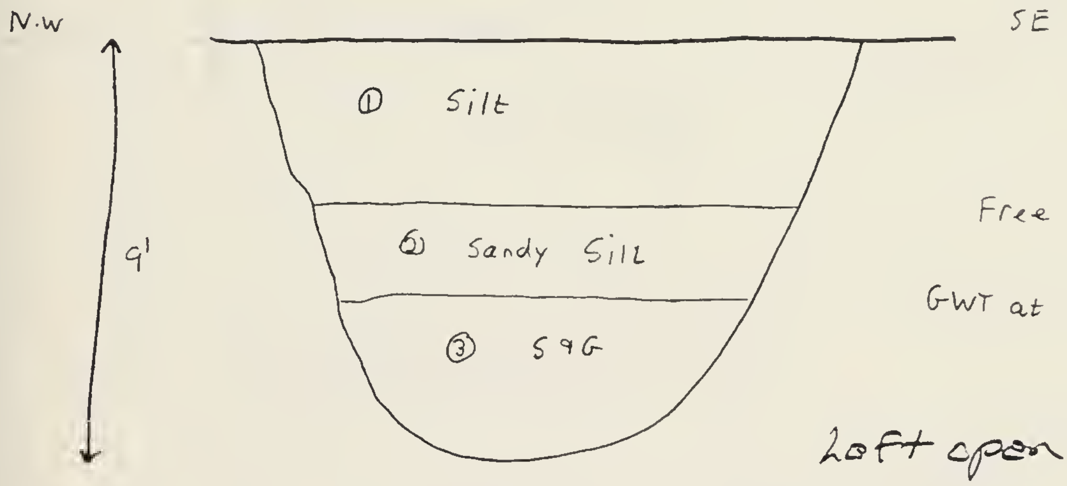
Location: 280' N W of TP-214 ; ~400 NE of Pond 1 ~~toe~~ trench

Coordinates: 811547N, 1172721E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1445 Finish: 1505

Photo: Roll 20 Frame 21 S.W wall w̄ no Flash
22 S.W wall



Free H_2O at 5.5'

GWT at 3.8' on 1-12-91

Left open

① 0-3.5' SILT: Grayish Brown & turns Grayer w̄ depth; <5% Sand; some organics, Plastic, Micaceous, Moist to Wet

② 3.5 - 5.5' SANDY SILT: Reddish Dull Gray; 5-10% Sand; Micaceous; 5-10% Gravels sticky, some organics; occasional calcite cemented chunks, Wet

③ 5.5 - 9' SAND & GRAVEL: Light Gray; 5" cobbles, no iron stains, same as TP-176 6.3'-11'

Sample: 1 small bag TP-215-1 1.5 - 2.5'
1 small bag TP-215-2 4.5 - 5.0'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-216 SHEET NO. 1 OF 1

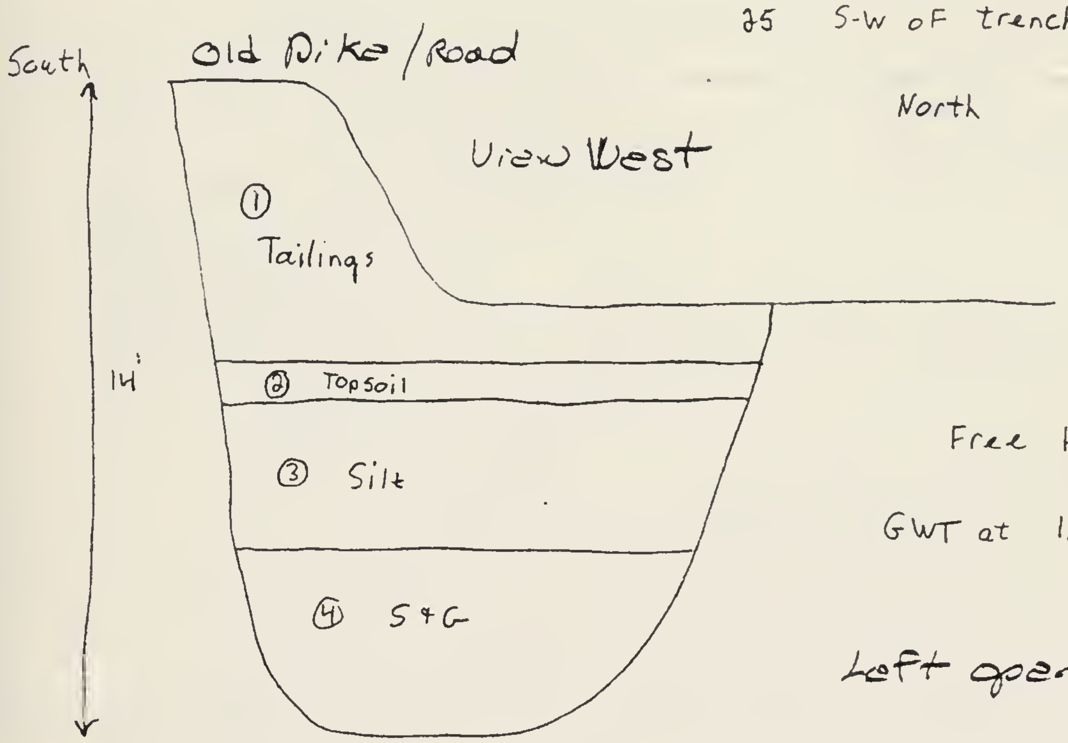
PROJECT WSP Below Pond 1 BY DATE 1-11-91

TP-216 Location: 500' NE of TP-215 ; ~750' NE of Pond 1 toe trench
Coordinates: 811982N, 1172974E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1510 Finish: 1535

Photo: Roll 20	Frame	23	Top of south end of trench did not turn out
		24	Bottom of south end of trench
		25	S-W of trench



Free H_2O at 6'

GWT at 1.0' on 1-12-91

Left open

① 0-6' TAILINGS: Browns, tans + greens, Fine sand Lenses

② 6-6.8' TOPSOIL: Black + Dark Red; Iron stained Fine to Med Sand mixed with Fine to Med Black sand; Micaceous, Loose; very organic Saturated

③ 6.8'-10' SILT: Grayish Black; < 5% Fine Sand; Plastic, Micaceous, Saturated

④ 10'-14' SAND + GRAVEL: Dark Gray; 70-80% Med to Coarse Sand; sluffs; very runny; saturated

Samples: 1 small bag TP-216-1 6.0-6.5'
1 Small bag TP-216-2 7.0-7.5'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-217 SHEET NO. 1 OF 1

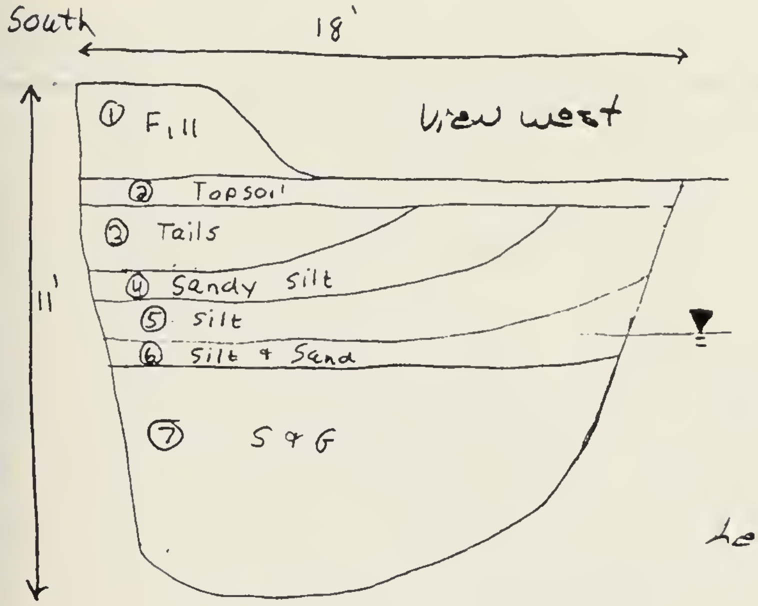
PROJECT WSP Below Pond 1 BY Jtr DATE 1-11-91

TP-217 Location: 200' NE of TP-216; ~950' NE Pond 1 toe trench
Coordinates: 812150N, 1173175E Ep

Contractor. JCI Machine: 690 Excavator Operator: Rich Orher

Start: 1545 Finish: 1615

Photo: Roll 21 Frame 1, 2 > taken in a vertical series



Machine Operated for 8 hours on 1-11-91
Total of 36 hours to Date

Free H_2O at 6.0'

GWT at 3.3' on 1-12-91

Left open

① 0-2' FILL: Light Brown; sandy silt - silty sand, Moist

② 2-2.5' TOPSOIL: Dark Brown to Black; sandy silt; some organics, Moist

③ 2.5-4' TAILINGS: Typical color + grain size

④ 4'-4.7' SANDY SILT: Reddish Brown; very fine iron stained sand, 20%; Moist

⑤ 4.7-5.4' SILT: Black; < 5% very fine sand; Plastic; some small organics, Micaceous Moist

⑥ 5.4-6' SANDY SILT - SILTY SAND: Gray, very fine "gritty" sand, Moist to Wet

⑦ 6-11' SAND + GRAVEL: Black; up to 4" cobbles; same as TP-126 6.3-11'

Samples:	1 small bag	TP-217-1	4.8 - 5.3'
	1 small bag	TP-217-2	5.5 - 6.0

JOB NO. 3381-7A SUBJECT TP-218 SHEET NO. 1 OF 1

PROJECT WSP BY Jte DATE 1-14-91

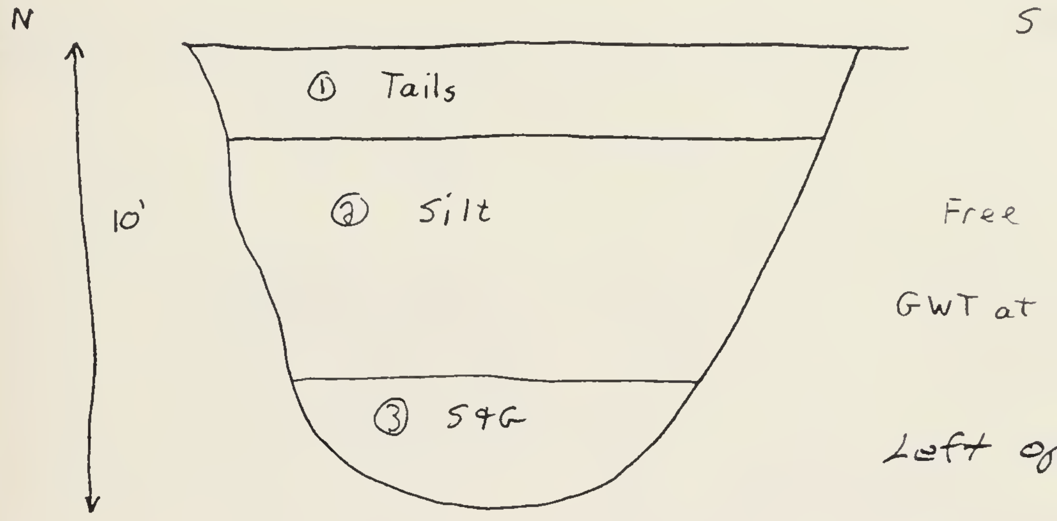
TP-218 Location: 400' N-E of TP-217; ~350' NE of old Silver Bow channel east side of valley below terrace

Coordinates: 812543 N, 1173249E 2/0

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0840 Finish: 0850

Photo: Roll 21 Frame 3 West Wall



Free H_2O at 7.2'

GWT at 4.4 on 1-19-91

Left open

① 0-2' TAILINGS: Light Brown, Tans & yellow; Typical tails

② 2'-7.2' SILT: Black; some organics, Micaceous, slightly Plastic, some iron stained sand Lenses; Moist

③ 7.2'-10' SAND & GRAVEL: Dark Gray; some organics; same as TP-176 6.3-11'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-219 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY DATE 1-14-91

Road/dike east side of valley

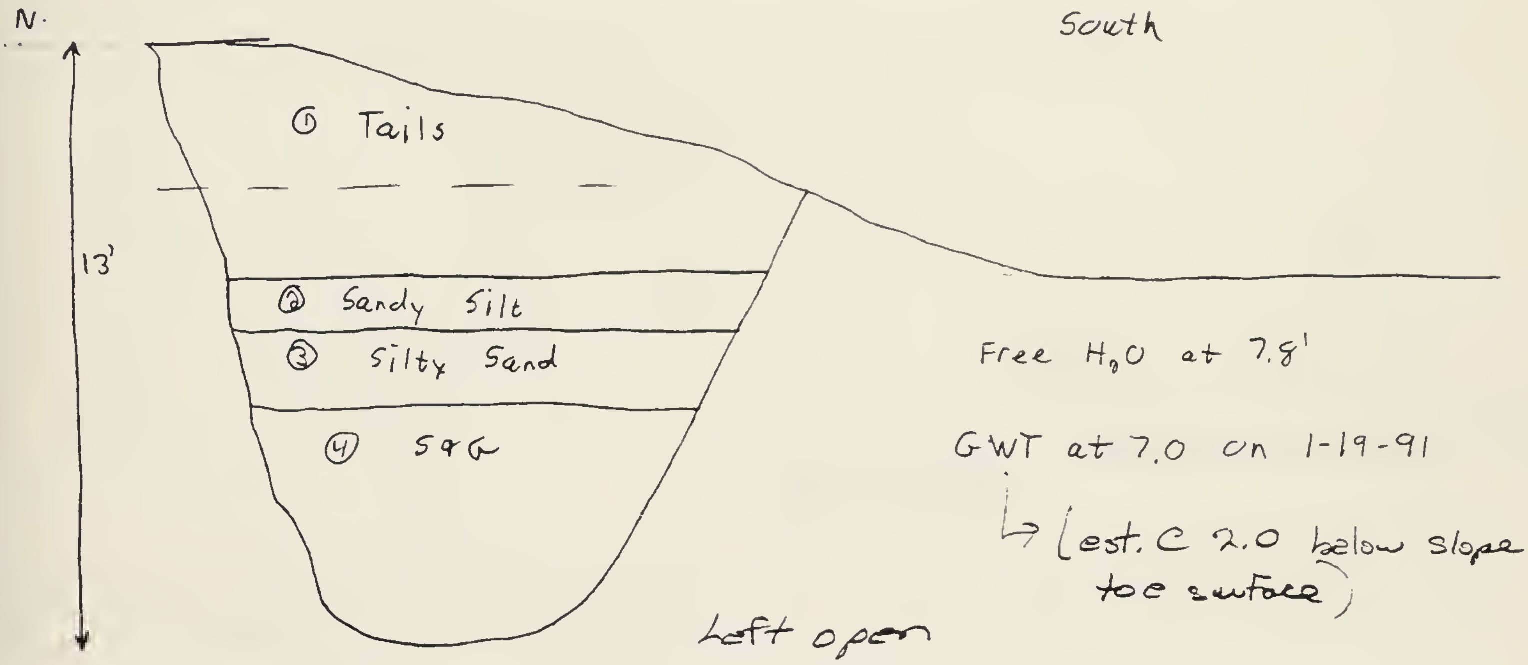
TP-219 Location: 250' SE of TP-218; ~350' NE old Silver Bow channel

Coordinates: 812339 N, 1173420E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0853 Finish: 0910

Photo: Roll 21 Frame 4 vertical series
5



Free H_2O at 7.8'

GWT at 7.0 on 1-19-91

↳ (est. @ 2.0 below slope toe surface)

Left open

① 0-5' TAILINGS: Lt Brown & yellow w̄ some organics

② 5-6.1' SANDY SILT: Light Browns, Tans & Dark Reds; Fine "gritty" sand; Micaceous; some organics, moist

③ 6.1-7.8' SILTY SAND: Dark Brown to Black; Some organics, Med grained sand; Micaceous; becomes wetter w̄ depth

④ 7.8-13' SAND & GRAVEL: Dark Gray to Black; no iron stains; same as TP-176 6.3-11'

Samples: 1 small bag TP-219-1 5.5'-6.0'
1 small bag TP-219-2 6.5-7.5'

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JOB NO. 3381-7A SUBJECT TP-220 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-14-91

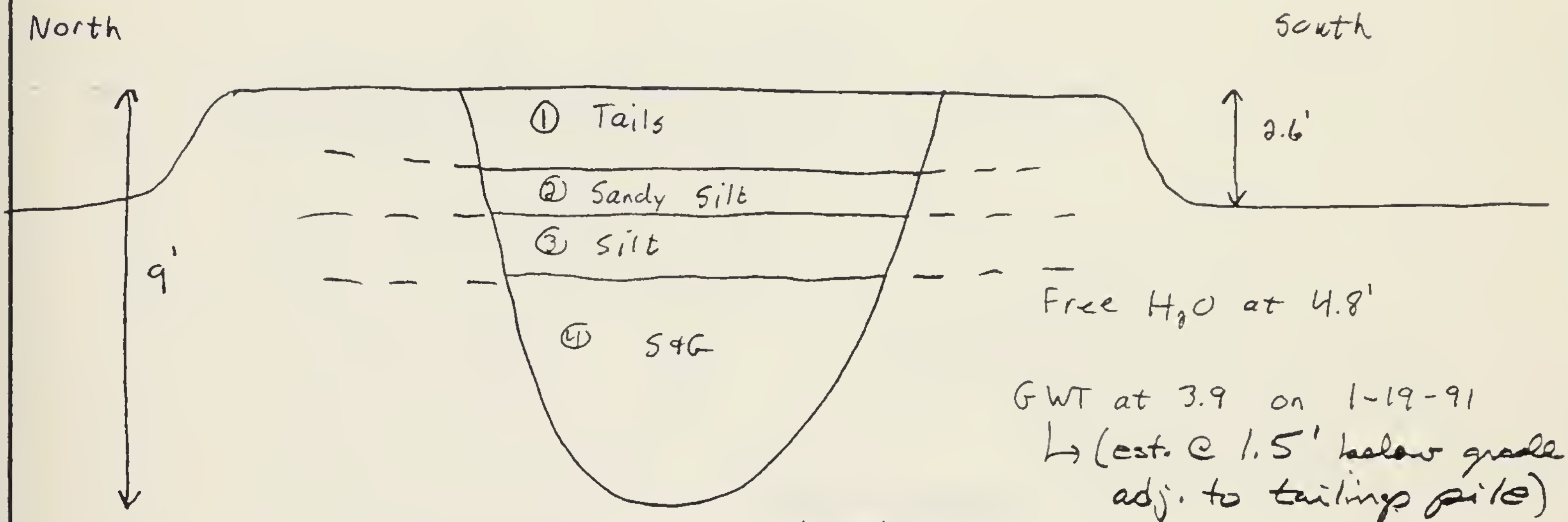
TP-220 Location: 350' SE of TP-219; ~350 NE of old Silver Bow Ck east side of valley below terrace

Coordinates: 812056N, 1173638E EJD

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 0915 Finish: 0925

Photo: Roll 21 Frame 6 East Wall



Free H_2O at 4.8'

GWT at 3.9 on 1-19-91
↳ (est. @ 1.5' below grade adj. to tailings pile)

Left open

① 0-1.8 TAILINGS: Tans & Browns

② 1.8-2.6 SANDY SILT: Dark Brown to Brownish Red, organics; Micaceous; Moist

③ 2.6-4' SILT: Black; 5% Fine Sand, micaceous; organic, slightly Plastic; Wet

④ 4-9' SAND & GRAVEL: heavily iron stained on Top, iron stains decrease w̄ depth
Same as TP-176 6.3-11'

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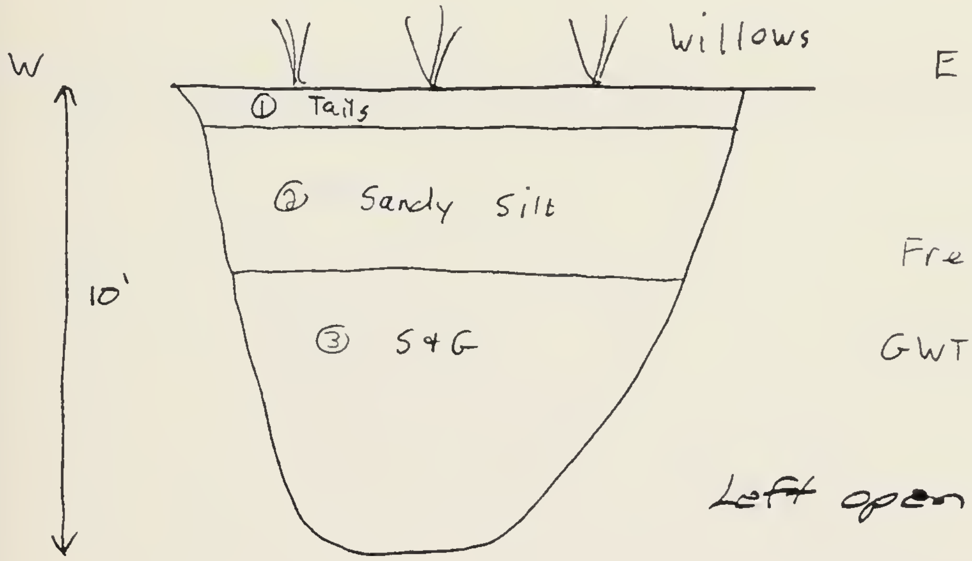
JOB NO. 3381-7A SUBJECT TP-221 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Jt DATE 1-14-91

TP-221 Location: 280' SE of TP-220; ~ 800 N of Pond 1 line shack
East side of valley
Coordinates: 811767N, 1173809E Ejs

Contractor: JCI Machine: 690 Excavator Operator: Rich Orher

Start: 0953 Finish: 1005
Photo: Roll 21 Frame 7



Free H_2O at 6'

GWT at 2.0 on 1-19-91

Left open

① 0-0.9' TAILINGS: Dark Green to Brown & Tan

② 0.9'-4' SANDY SILT: Dark Brown & Black; 5% Fine Sand; Micaceous; root zone & other organics, Plastic; Moist to Wet

③ 4'-10' SAND & GRAVEL: Greens & Dark Gray; same as TP-176 6.3-11'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-222 SHEET NO. 1 OF 1

PROJECT WSP BY Jtc DATE 1-14-91

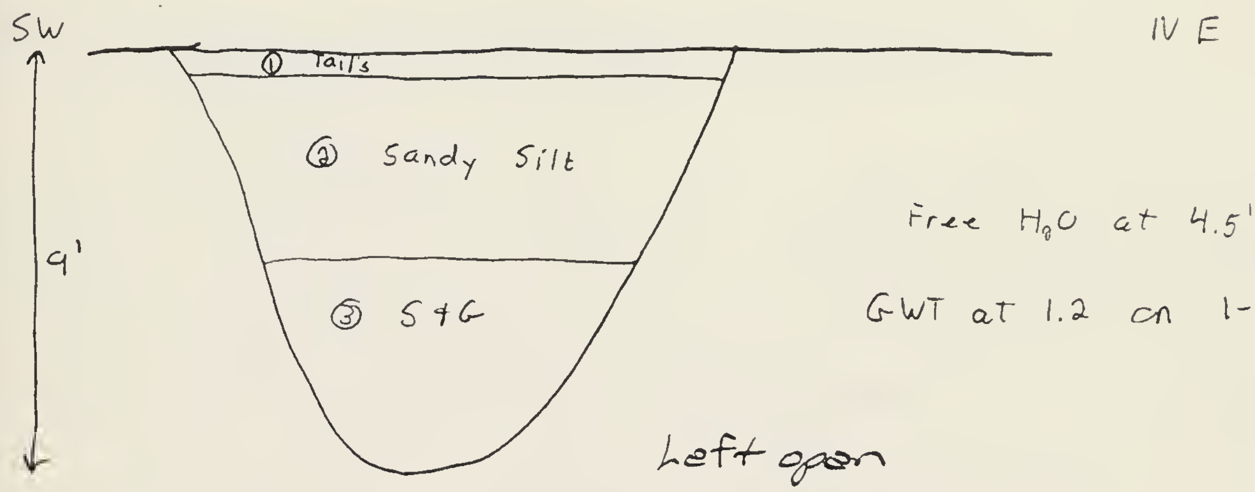
TP-222 Location: 650' S of TP-221; ~250' N of Pond 1 dike East side of valley

Coordinates: 811114N, 117 3721E

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1010 Finish: 1015

Photo: Roll 21 Frame 8



Free H_2O at 4.5'

GWT at 1.2 on 1-19-91

Left open

① 0-0.4' TAILINGS: Typical Tails

② 0.4' - 4.5' SANDY SILT: Black to DK brown; < 5% Fine sand; Micaceous; Plastic organics; turns DK Gray w̄ depth; Moist to Wet

③ 4.5' - 9' SAND & GRAVEL: Very Loose; Same as TP-176 6.3-11'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-223 SHEET NO. 1 OF 1

PROJECT WSP Below Pond 1 BY Gtc DATE 1-14-91

TP-223

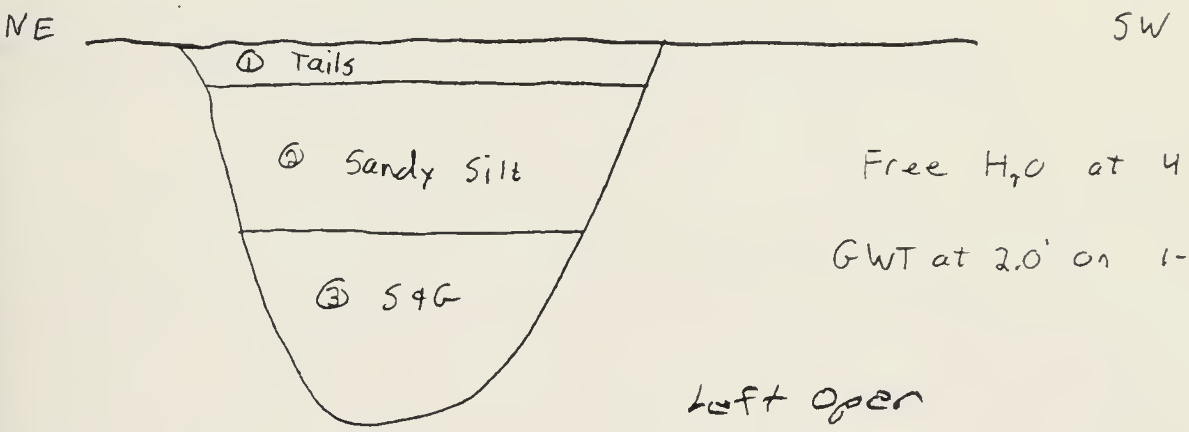
Location: 130' NE of TP-222; east side of valley ~350 N of Pond 1 dike

Coordinates: 811250N, 1173815E zjo

Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start: 1020 Finish: 1030

Photo: None Camera would not work



Free H_2O at 4'

GWT at 2.0' on 1-19-91

Left Open

① 0-0.9' TAILINGS: Typical Tails

② 0.9'-4' SANDY SILT: Black to Dark Gray; same as TP-222 0.4'-4.5'

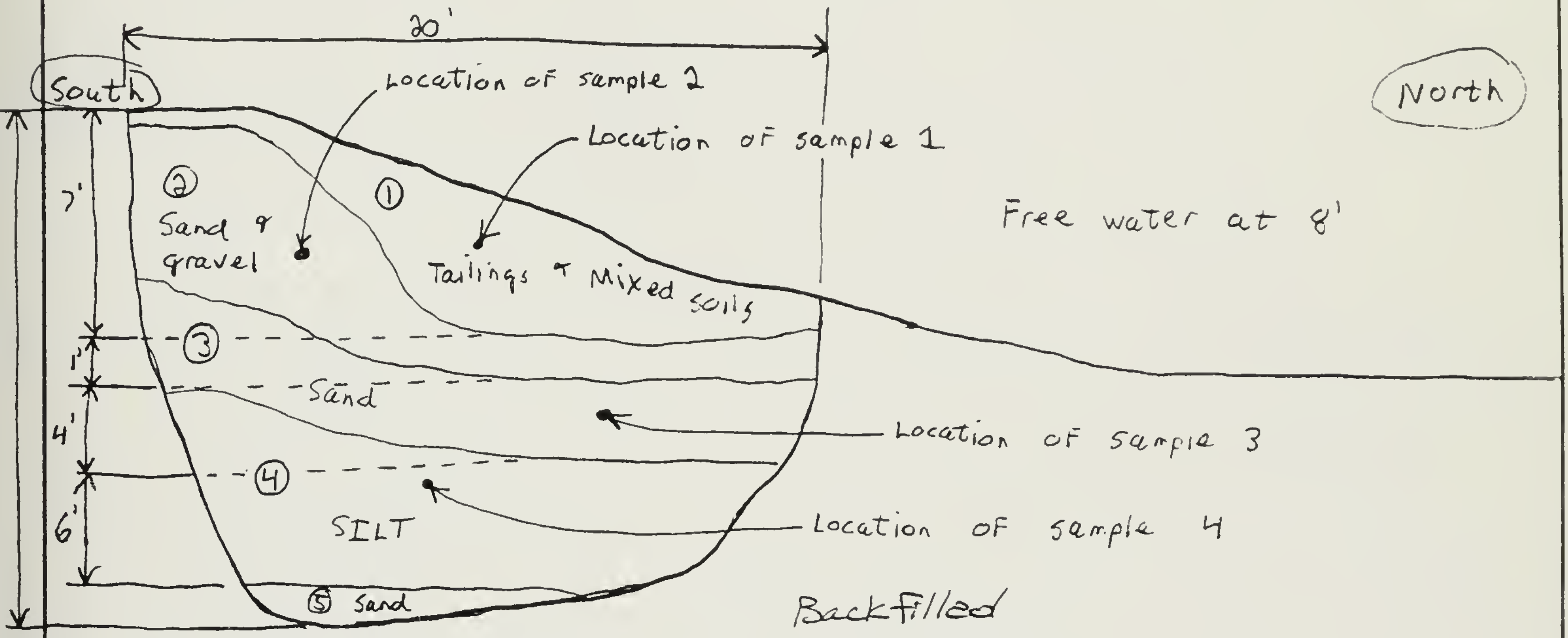
③ 4'-8' SAND & GRAVEL: Dark Green to Dark Gray, no iron stains; same as TP-176 6.3'-11'

ESA Consultants

JOB NO. 3381-7A SUBJECT TP-224 SHEET NO. 1 OF 1
PROJECT WSP East end Pond 1 Dike BY gte DATE 1-14-91

TP-224 Location: 120' West of Lime Shack - Pond 1 Dike
Coordinates: 810772 N, 1173886 E Crest = downstream Slope EF
Contractor: JCI Machine: 690 Excavator Operator: Rich Orhen

Start - 1045 Finish - 1120
Photo: Roll 21 Frames 10 + 11 (shovel was kept in same place)



Note: all measurements are referenced to the top of the dike

① 0-7' MIXED SOILS + TAILINGS: Brown to Dark Red; very Loose, Low density Sandy Silt; 5% very Fine sand; some organics; Dry to Moist

② 7'-8' SAND + GRAVEL: Dull Gray; 5-10% Fines, 40-50% Fine to Med Sand; Fairly Dense; Dry to Moist

③ 8'-12' SILTY SAND: Light Gray; 10-15% Fines, 60% Fine to coarse sand, <5% small gravels; Moist; some of the material Forms chunks that are easily broken

④ 12'-18' SILT: Black to Dark Gray; Plastic, sticky; Some Fine to med grained sand Lenses; Moist to wet; Some Large, man-made organics.

⑤ 18-19' SAND: could not retrieve a sample, the machine could not dig any deeper.

Samples 1 small bag, TP-224-1 4-5'; 1 small bag, TP-224-2 4-5'; 1 small bag, TP-224-3 10-11'; 1 small bag, TP-224-4 12-13'

Due to Lack of stability, the Test Pit had to be Filled in.

APPENDIX B

COST ESTIMATES

Cost Estimates

Cost estimates have been prepared on a basis consistent with those previously developed for the original WSP Feasibility Study (FS). For those media-specific actions (MSAs) which are similar to the FS, adjustments have been made to unit prices or quantities where new data indicate a change is appropriate.

Due to the large number of MSAs and the resulting combinations, several alternatives involve slight modifications to the MSAs as they are defined in the text. These modifications are identified in the footnotes to Table B-3, Alternatives Cost Summary.

Cost estimates do not include costs for engineering, administration, or monitoring. Although not determined as of this time, it is clear that such costs would be similar for all alternatives. Consequently, they would have little bearing on the overall comparative evaluation of cost.

TABLE B–1
DETAIL COSTS OF MEDIA SPECIFIC ACTIONS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
MSA-1A				
DIKE IMPROVEMENTS,EAST-WEST DIKE OF POND 1				
Clearing and Stripping	6	AC	$7,500.00	$45,000
Foundation Excavation	5,000	CY	$7.60	$38,000
Gravel Fill	5,000	CY	$7.60	$38,000
Embankment	17,000	CY	$4.50	$76,500
Gravel Surface	1,700	CY	$10.00	$17,000
TOTAL				$214,500
MSA-1B				
DRY CLOSE ALL OF POND 1				
Finish Grading	290	AC	$1,520.00	$440,800
Geogrid	1,400,000	SY	$3.00	$4,200,000
2" Limestone Cap	116,000	TONS	$13.00	$1,508,000
Random Fill	560,000	CY	$8.00	$4,480,000
6" Soil Cover	234,000	CY	$5.00	$1,170,000
Phosphast Fertilizer	145	TONS	$325.00	$47,125
Seeding	290	AC	$1,000.00	$290,000
Riprap	800	CY	$30.00	$24,000
TOTAL				$12,159,925
MSA-1C				
EAST HILLS FLOOD INTERCEPTOR CHANNEL - POND 1				
Clearing and Stripping	13	AC	$7,600.00	$98,800
Channel Excavation	80,000	CY	$6.84	$547,200
Geofabric	42,000	SY	$4.50	$189,000
Riprap	14,000	CY	$30.00	$420,000
TOTAL				$1,255,000
MSA 1D				
DRY CLOSURE OF POND 1 - WESTERN PORTION				
Finish Grading	175	AC	$1,520.00	$266,000
Geogrid	847,000	SY	$2.28	$1,931,160
2" Limestone Cap	70,000	TONS	$13.00	$910,000
Random Fill	340,000	CY	$6.00	$2,040,000
6" Soil Cover	140,000	CY	$5.00	$700,000
Phosphate Fertilizer	90	TONS	$325.00	$29,250
Seeding	175	AC	$1,000.00	$175,000
Riprap	600	CY	$30.00	$18,000
TOTAL				$6,069,410

TABLE B-1 (cont'd)
DETAIL COSTS OF MEDIA SPECIFIC ACTIONS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
MSA 1-E WET CLOSURE/CHEMICAL FIXATION OF POND 1 - EASTERN PORTION				
Lime Conditioning	115	AC	$4,000.00	$460,000
Wet Closure Dikes	20,000	CY	$10.00	$200,000
Geogrid Foundations	15,000	SY	$4.00	$60,000
Soil Cement Overflows	500	CY	$50.00	$25,000
Riprap	600	CY	$30.00	$18,000
Siphon From Pond 2	1	LS	$20,000.00	$20,000
TOTAL				$783,000
MSA 2-A POND 1 DIKE EXTENSION - AREA BELOW POND 1				
Embankment	75,000	CY	$5.00	$375,000
Foundation Excavation	20,000	CY	$10.00	$200,000
Underdrain	2,400	LF	$10.00	$24,000
Soil Cement Erosion Protection	15,000	CY	$30.00	$450,000
TOTAL				$1,049,000
MSA 2-B EAST HILLS FLOOD INTERCEPTOR CHANNEL - AREA BELOW POND 1				
Clearing and Stripping	5	AC	$7,500.00	$37,500
Channel Excavation	110,000	CY	$6.84	$752,400
Geofabric	15,000	SY	$4.50	$67,500
Riprap	5,000	CY	$30.00	$150,000
TOTAL				$1,007,400
MSA 3-A WET CLOSURE/CHEMICAL FIXATION - AREA BELOW POND 1				
Lime Conditioning	74	AC	$4,000.00	$296,000
Wet Closure Dikes	20,000	CY	$10.00	$200,000
Geogrid	17,000	SY	$4.00	$68,000
Soil Cement Overflows	1,000	CY	$50.00	$50,000
Riprap	1,000	CY	$30.00	$30,000
Siphon from Pond 2	1	LS	$20,000.00	$20,000
Tailings/Soils Removal	50,000	CY	$12.00	$600,000
Habitat Enhancement	30,000	CY	$8.00	$240,000
TOTAL				$1,504,000

TABLE B-1 (cont'd)
DETAIL COSTS OF MEDIA SPECIFIC ACTIONS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
MSA 3-B				
REMOVE TAILINGS & ASSOCIATED SOILS - AREA BELOW POND 1				
Clearing and Grubbing	70	AC	$7,500.00	$525,000
Dewatering/Runoff Control	1	LS	$1,200,000	$1,200,000
Removal Excavation	590,000	CY	$12.00	$7,080,000
6" Topsoil	57,000	CY	$5.00	$285,000
Phosphate Fertilizer	35	TONS	$325.00	$11,375
Seeding	70	AC	$1,000.00	$70,000
TOTAL				$9,171,375
MSA 3-C				
DRY CLOSURE - AREA BELOW POND 1				
Clearing and Grubbing	70	AC	$7,500.00	$525,000
2" Limestone Cap	28,000	TONS	$13.00	$364,000
Random Fill	130,000	CY	$6.00	$780,000
6" Soil Cover	57,000	CY	$5.00	$285,000
Phosphate Fertilizer	35	TONS	$325.00	$11,375
Seeding	70	AC	$1,000.00	$70,000
TOTAL				$2,035,375
MSA 4-A				
GROUND-WATER INTERCEPTION AND PUMPBACK SYSTEM - POND 1				
Construct Drains	150,000	CY	$6.00	$900,000
Level Spoils	150,000	CY	$2.00	$300,000
Pump Station	1	LS	$250,000.00	$250,000
Piping	10,000	LF	$35.00	$350,000
TOTAL				$1,800,000
MSA 4-B				
GROUND-WATER INTERCEPTION AND PUMPBACK SYSTEM - BELOW POND 1				
Interceptor Excavation	55,000	CY	$6.00	$330,000
Tailings Removal	5,000	CY	$7.00	$35,000
Pump Station	1	LS	$250,000.00	$250,000
Pipeline	15,000	LF	$35.00	$525,000
TOTAL				$1,140,000

TABLE B-1 (cont'd)
DETAIL COSTS OF MEDIA SPECIFIC ACTIONS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST
MSA 4-C				
GROUND-WATER INTERCEPTION AND PUMPBACK SYSTEM - TOE OF POND 1 DIKE				
Interceptor Excavation	45,000	CY	$6.00	$270,000
Tailings Removal	5,000	CY	$7.00	$35,000
Pump Station	1	LS	$250,000.00	$250,000
Pipeline	10,000	LF	$35.00	$350,000
TOTAL				$905,000
MSA 4-D				
MILL-WILLOW BYPASS CHANNEL REPLACEMENT				
Channel Excavation	25,000	CY	$4.00	$100,000
Tailings Removal	5,000	CY	$7.00	$35,000
TOTAL				$135,000

TABLE B-2
OPERATION AND MAINTENANCE COST

	DC POND 1 REM BELOW	DC POND 1 WC BELOW	DC POND1 DC BELOW	W-D POND 1 REM BELOW	W-D POND 1 WC BELOW	W-D POND 1 DC BELOW
COST ELEMENT	Alternative No.1	Alternative No.2	Alternative No.3	Alternative No.4	Alternative No.5	Alternative No.6
Cap Maintenance	$5,000	$5,000	$10,000	$5,000	$5,000	$10,000
Pumping Cost	$15,000	$20,000	$20,000	$15,000	$20,000	$20,000
Pipeline Repairs	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Wet Closure Operation		$10,000		$10,000	$20,000	$10,000
Wet Closure Repairs		$10,000		$10,000	$20,000	$10,000
TOTAL	$25,000	$50,000	$35,000	$45,000	$70,000	$55,000

TABLE B-3
ALTERNATIVES COST SUMMARY

	DC POND 1 REM BELOW	DC POND 1 WC BELOW	DC POND1 DC BELOW	W-D POND 1 REM BELOW	W-D POND 1 WC BELOW	W-D POND 1 DC BELOW
MEDIA SPECIFIC ACTION	Alternative No.1	Alternative No.2	Alternative No.3	Alternative No.4	Alternative No.5	Alternative No.6
1-A Dike Improvements, East-West Dike of Pond 1	$214,500	$214,500	$214,500	$214,500	$214,500	$214,500
1-B Dry Close All of Pond 1	$12,159,925	$12,159,925	$12,159,925			
1-C East Hills Flood Interceptor Channel - Pond 1	$1,255,000	$1,255,000	$1,255,000	$1,255,000	$1,255,000	$1,255,000
1-D Dry Closure of Pond 1 - Western Portion				$6,069,410	$6,069,410	$6,069,410
1-E Wet Closure/Chemical Fixation of Pond 1 - Eastern Portion				$783,000	$783,000	$783,000
2-A Pond 1 Dike Extension - Area Below Pond 1		$1,049,000	$1,049,000		$1,049,000	$1,049,000
2-B East Hills Flood Interceptor Channel - Area Below Pond		$1,007,400	$1,007,400		$1,007,400	$1,007,400
3-A Wet Closure/Chemical Fixation - Area Below Pond 1		$1,504,000			$1,504,000	
3-B Remove Tailings & Associated Soils - Area Below Pond 1	$9,171,375			$9,171,375		
3-C Dry Closure - Area Below Pond 1			$2,035,375			$2,155,375 (2)
4-A Ground-Water Interception & Pumpback Sys - Pond 1	$1,800,000	$1,450,000 (1)	$1,450,000 (1)			
4-B Ground-Water Interception & Pumpback Sys-Below Pond 1	$0	$1,140,000	$1,140,000		$1,140,000	$1,140,000
4-C Ground-Water Interception & Pumpback Sys-Toe Pond 1 Dike				$905,000		
4-D Mill-Willow Bypass Channel Replacement		$135,000	$135,000		$135,000	$135,000
BASIC CONSTRUCTION COST	$24,600,800	$19,914,825	$20,446,200	$18,398,285	$13,157,310	$13,808,685
DIVISION 1 ADDITIONAL (3)	$2,706,088	$2,190,631	$2,249,082	$2,023,811	$1,447,304	$1,518,955
CONTINGENCY (4)	$3,690,120	$2,987,224	$3,066,930	$2,759,743	$1,973,597	$2,071,303
TOTAL CONSTRUCTION COST	$30,997,008	$25,092,680	$25,762,212	$23,181,839	$16,578,211	$17,398,943
OPERATION & MAINTENANCE	$25,000	$50,000	$35,000	$45,000	$70,000	$55,000
PROJECT PRESENT WORTH (5)	$31,381,321	$25,861,305	$26,300,250	$23,873,602	$17,654,286	$18,244,431

(1) Return flow piping is deleted from total MSA cost, pipe cost included in 4-B.

(2) N-S trench extension through dry closure added to basic MSA cost ($120,000).

(3) 11% of Basic Construction Cost

(4) 15% of Basic Construction Cost

(5) Present worth is calculated by amortizing the Operation and Maintenance cost over 30 years at 5 percent.